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PROCESSES AND INTERFIRM COLLABORATION IN DELIVERING INTEGRATED SOLUTIONS

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ABSTRACT

ELISA LUKIN: Processes and interfirm collaboration in delivering integrated solutions
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The complexity of the projects in the gas and energy sector is increasing and the public sector is increasingly privatizing these projects thus, the emergence of BOT (Build-Operate-Transfer) projects. In BOT projects the contractor takes on additional responsibilities compared to an Engineer-Procure-Construct (EPC) project. However, acting as a solution provider requires a change in the business mindset of the company and need for additional capabilities such as: business consultation, systems integration, operational service and financial capabilities. The contractor needs to either incrementally develop these capabilities or collaborate with a project partner. Interfirm collaboration increases the complexity in the management of the project and therefore, increases the project risk. Companies need to develop collaborative practices to mitigate the risks in delivering these kinds of integrated solutions.

The objective of this study to develop the understanding of the requirements and processes needed to deliver integrated solution projects. This study was conducted for a small firm, which delivers integrated solution projects through collaborating with project partners. The study was done through a constructive approach where the theoretical and empirical process models could be compared between each other. The empirical process model was constructed through gathering information from semi-structured interviews and from a workshop.

This study resulted in the creation of new understanding of the processes and requirements for an SME (Small or medium-sized enterprise) to deliver integrated solutions by collaborating with other companies. The four main capabilities for delivering integrated solutions were found in the project network and spread between the project partners. The complementary capabilities were main reason for the partners to choose to collaborate with each other. In integrated solution deliveries, the pre-project phase is extended as found out in the case project thus a clearer clarification between the value proposition and systems integration phase was needed. Challenges in the interfirm collaboration process were described to be mainly due to communication practices and the lack of a collaborative management style. In the future, more case studies with similar settings or as a longitudinal study to study the whole integrated solution lifecycle would be needed. Additionally, studying the risks of collaboration and what causes design changes in IS projects would be beneficial.

TIIVISTELMÄ

ELISA LUKIN: Prosessit ja yritysten välinen yhteistyö integroitujen ratkaisujen toimitusprojekteissa
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Tuotantotalouden diplomi-insinöörin tutkinto-ohjelma
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Avainsanat: integroidut ratkaisut, prosessi, yritysten välinen yhteistyö

Kaasu- ja energiasektorien projektien monimutkaisuus kasvaa ja julkinen sektori hankkii investointiprojektinsa enenevissä määrin yksityisiltä palveluntarjoajilta. Tämän vuoksi elinkaariratkaisuprojektit ovat ilmestyneet markkinoille. Elinkaariratkaisuprojekteissa toimeksisaaja saa lisää vastuuta verrattuna – kokonaistoimitusprojektiin esimerkiksi elinkaaripalveluiden muodossa. Toimiminen ratkaisutoimittajana edellyttää liiketoimintatavan muutosta sekä uusien kyvykkyyksien omaamista. Näitä ovat esimerkiksi liiketoiminnan konsultointi, systeemien integrointi, operointipalvelu sekä rahoituskyvykkyydet. Toimeksisaajan tulee joko kehittää nämä kyvykkyydet itse tai etsiä yhteistyökumppaneita, joilta ne löytyvät. Yhteistyö projektikumppanin kanssa aiheuttaa projektiin omat haasteensa, sillä se kasvattaa projektin monimutkaisuutta. Onkin tärkeää, että yritykset ottavat huomioon erilaiset tavat tehdä yhteistyötä, jotta projektitoimituksen riskejä voidaan alentaa.

Tämän tutkimuksen tavoite on ymmärtää paremmin millaisia edellytyksiä ja millaisin toimitusprosessein integroituja ratkaisuja voidaan toimittaa yhteistyössä projektikumppaneiden kanssa. Tämä tutkimus on toteutettu pienelle yritykselle, joka toimittaa integroitujen ratkaisujen toimitusprojekteja tekemällä yhteistyötä erilaisten projektipartnereiden kanssa. Tutkimus on konstruktiivinen, jolloin teoreettista sekä empiiristä prosessimallia voitiin verrata keskenään. Empiirinen prosessimalli on rakennettu keräämällä tietoa puolistrukturoitujen haastatteluiden sekä työpajan avulla.

Tutkimus johti uuden ymmärryksen luomiseen siitä, millaisin prosessein ja millaisia edellytyksiä integroitujen ratkaisujen toimittamiseen kuuluu pienelle tai keskisuurelle yritykselle, joka tekee yhteistyötä projektipartnerien kanssa. Integroidun ratkaisun pääkyvykkyydet löytyivät projektiverkostosta ja ne olivat jakautuneet projektikumppaneiden kesken. Toisiaan täydentävät kyvykkyydet olivat pääsyy kumppaneiden väliselle yhteistyölle. Integroitujen ratkaisujen toimitusprojekteissa projektia ennen tapahtuva jakso on pidempi. Tämän vuoksi arvolupauksen tekemisen ja systeemien integrointivaiheen eriyttäminen oli tärkeää selkeyttää. Lisäksi havaittiin, että ratkaisun kokeileminen prototyypeillä projektin alkuvaiheessa oli tärkeää. Sen vuoksi, että kokeilujen tulokset vaikuttavat merkittävästi kokonaisratkaisuun. Projektipartnereiden välisen yhteistyön haasteet olivat pääosin kommunikaatiokäytännöissä sekä johtamistyylin muuttamista yhteistyökeskeiseksi kontrolloivan sijaan. Samankaltaiset case-tutkimukset, pitkittäistutkimus ratkaisun koko elinkaarelta sekä yhteistyön riskeistä olisi hyödyllistä jatkotutkimuksen kannalta.

ALKUSANAT

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"It's a dangerous business, Frodo, going out your door. You step onto the road, and if you don't keep your feet, there's no knowing where you might be swept off to."

J.R.R. Tolkien

Tampere, 26.4.2019

Elisa Lukin

CONTENTS

LIST OF SYMBOLS AND ABBREVIATIONS

CoPS	Complex Products and Systems
BOT	Build-Operate-Transfer
DBOT	Design-Build-Operate-Transfer
EPC	Engineer-Procure-Construct
EPCM	Engineer-Procure-Construct-Manage
HazOp	Hazard and Operability
IS	Integrated Solution
LLC	Limited liability company
O&M	Operations & Maintenance
PBF	Project-based Firm
SME	Small- or Medium-sized Enterprise

1. INTRODUCTION

1.1 Background

The significance of the systems integration grows with higher complexity, technology and costs. Therefore, Hobday, Davies and Prencipe (2005) argued that systems integration is more than merely a technical or operational task but rather a core capability of several high technology companies. The gas supply industry has been one of the several fields which has been affected by privatization. Privatization of public systems is an important factor opening new markets for system integrators. Systems integration in the broadest sense can be defined as *"the capabilities which enable firms, government agencies, regulators, and a range of actors to define and combine together all the necessary inputs for a system and agree on a path of future systems development."* (Hobday et al., 2005)

On the other hand, companies providing these complex products and systems (CoPS) have been moving towards providing solutions. This means combining services with the individual products. The need for solutions where the supplier takes more responsibility and risk has been growing since 1980's. Thus, the emergence of Build-Operate-Transfer (BOT) projects where the contractor takes additional responsibilities compared to an Engineer-Procure-Construct (EPC) delivery project. (Brady, Davies, & Gann, 2005) Typically, in BOT projects there is a public or private entity which grants a private sector organization the finance, design, construct, and operational tasks for a certain period. The ownership of e.g. a construction plant constructed will be reverted to the entity which ordered the project after a certain time. (Lam, 1999) On the other hand, DBOT (Design, Build, Operate, Transfer) projects include also the design of the solution.

Project which combine complex products and systems (CoPS) with services, can be called integrated solution (IS) projects. However, the development towards solution-orientation does not come without challenges. Integrating together complex products and systems while providing services such as financial, operational service and business consultation leads to even more complex projects with highly networked interfirm connections. This increases the size and interconnections in the project thus leading to greater complexity. An underestimation of project complexity can be one of the reasons for a project to fail (Bosch-Rekveldt, Jongkind, Mooi, Bakker, & Verbraeck, 2011) Complexity is therefore, an important aspect to study and according to Geraldi (2009) the *"assessment of* *complexity itself is a tool to enable - - active management".* Explicitly classifying project efforts and selecting the best approach for a specific project is challenging since there are no standard frameworks for distinguishing them (Shenhar, Dvir, Lechler, & Poli, 2002).

Projects can be viewed from different points of view, one of which is seeing it as a process with sequential tasks. According to (Shenhar, 1998) the project execution phase starts usually either when a customer signs a contract or the company is presenting a new product to the marketplace. However, offering integrated solutions means extending the project from the project execution phase to cover also the pre-bid and after-sales phase (Brady et al., 2005). Projects are a suitable way in delivering these kinds of complex systems which require extensive integration between the different stakeholders (Hobday, 2000; Martinsuo & Ahola, 2010).

Collaboration between project partners can offer significant benefits such as gaining access to new knowledge bases thus enabling a faster integration to international markets (Saarenketo, Puumalainen, Kuivalainen, & Kyläheiko, 2004). However, there are also significant risks since collaboration in these kinds of temporary settings can be challenging, especially when lacking prior experience of working together. According to the Financial Times (2016) conflicts between project partners is one of the biggest risks in large engineering projects. In order to control the risks of collaboration between project partners companies can focus on using collaborative or controlling methods in order to integrate the partner or supplier to the project (Martinsuo & Ahola, 2010).

In this thesis the focus will be on studying the requirements and the process of delivering an integrated solution as a DBOT delivery project. The pre-project and design phases are studied mainly from the point of view of the case company which acts as a systems integrator in the project providing one of the key technologies for the projects. The benefits and challenges of collaborating with a project partner are also studied.

1.2 Empirical context

The case company is an SME (Small or Medium-sized Enterprise) providing an innovative technology for utilizing highly specialized biomasses in biogas production. The markets for technologies using this biomass type are still considerably new and there are just a few existing biogas plants. The case company divides their projects to greenfield and add-on projects. The greenfield projects are projects where there is no existing power plant. Add-on projects on the other hand are power plants where the company adds their technology to enhance the biogas production or enable the usage of difficult waste types. The company has three main customer segments; power plant operator, public sector, and private entities such as investors. To serve these customers in different biographical markets the case company has different business units, a project services unit and headquarters. The case company structure can be seen in the Figure 1 below.

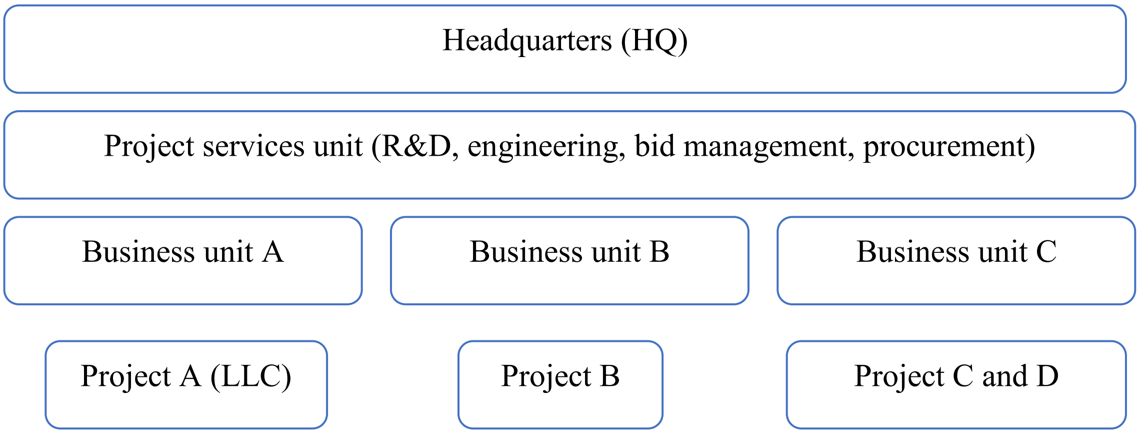

Figure 1. *The case company structure*

The headquarters refers to the top management of the company. The project services unit provides the different project services such as sales support, engineering, R&D. Usually one or two members are allocated for each project and for each project phase such as process engineering, procurement, or automation. However, the sales and the development tasks of the projects happen in the different business units which are located in the different geographical markets. The different business units own the projects and the project services unit provides the systems integration for them. Sometimes a limited liability company (LLC) is established to incorporate other project stakeholders such as the public sector, investors and project partners to the delivery projects.

One of the peculiarities of the case is how the company is delivering different project types depending of the need of the markets and customer segments. Acting as a system integrator has been one of the ways for the company to open their business in several markets. The company's product itself can be categorized as a complex product. Combining it to a complex system with other complex products requires systems integration capabilities. The company is delivering the projects through collaborating with different project partners due to the size and maturity of the company. This way the company can ensure all the necessary capabilities can be found in the project network to deliver a DBOT project where the company takes on additional responsibilities compared to an EPC delivery of a complex product or system.

1.3 Research objectives and scope

The operations management body of literature is lacking in studying the process of delivery projects and the “fit” between the analysis of project complexity to those processes (Geraldi, Maylor, & Williams, 2011; Geraldi, 2009). On the other hand, integrated solutions are usually delivered by large companies which have the resources in-house to deliver services such as financing, design, and consultation services (Davies et al. 2004). However, there are few studies which focus on how SMEs can realize these kinds of projects through interfirm collaboration. Interfirm collaboration between different SMEs has been focused on studying the creation of manufacturing networks rather than in the project business landscape.

SMEs do not necessarily have all the resources and capabilities to do everything in-house. Therefore, they need to do strategic partnerships to deliver large and complex engineering projects. Interfirm collaboration has been seen previously to gain competitive advantage compared to large companies resource wise, however the bigger advantage could lay in the capability building. This study aims to understand and identify the requirements of delivering integrated solutions. Thus, the objectives of this research are to study the processes needed for an SME to deliver integrated solutions where interfirm collaboration might play an important part.

Research questions:

> *RQ1. What are the requirements for a project-based firm to act as an integrated solution provider?*
>
> *RQ2. Through what kinds of processes can small- and medium sized businesses provide integrated solutions?*

These questions are answered through a case study of two different projects. Differences and similarities between the different projects are studied by semi-structured interviews and a 2-day workshop. The thesis project itself is an internal process development project between the case company and one of the project partners.

The scope of the project focuses on studying the pre-project and the early phase of the two case projects. This early phase of the project can be called the engineering or design phase of the project depending of the project type. On this phase the project services unit design the solution together with the business units. The two project types which are studied are EPC and BOT projects. A BOT includes additional services such as designing, financing, operating and managing or business consulting. On this case the company’s project A could be described as a Design, Build, Operate, Transfer (DBOT) project.

Project B on the other hand is an Engineer, Procure, Construct (EPC) delivery project of the company's own technology where the company will also maintain the technology. Since, the technology is a relatively new one, it is especially interesting to study how the technological uncertainty can affect the design and engineering of the solution. The focus of the study is on the project A and project B was chosen to compare these two project types with each other.

1.4 Structure of the thesis

This study starts next with a literature review of the main themes of this thesis. Project complexity and its implications to project management are studied first to get a general understanding of what kind of requirements different kinds of complexities bring to project management. The second subchapter dives more deeply into the theory about integrated solutions and especially what are the requirements of delivering those. Also, highlighting how the process differs from more traditional product-centered projects presented in the first subchapter. On the third subchapter interfirm collaboration and project networks are studied since it is a way for small- and medium sized companies to deliver large integrated solution projects.

The third chapter presents the nature of the research and the data collection methods. The delivery projects A and B were chosen for the study since they were the most advanced and approximately at the same phase during the beginning of the study. Data from these projects was collected through semi-structured interviews, workshop and observing project meetings. The data was collected from team members and members of one project partner. Along the interviews a process model of both projects was created and used in the next interviews to build on existing empirical findings.

The fourth chapter presents the results of the empirical study. Interesting results were found related to the challenges in systems integration for the case company and in way the current processes of the different project types. In the conclusions it was found out how integrated solution capabilities were divided between the project partner and how the created future model for the integrated solution process model was aligned with the theory framework which was created in the literature study. The existing framework was updated to include collaborative relationship management as a support process in addition to the financial and business consultation services. The main benefit of interfirm collaboration was found to be the complementary capabilities the two companies had, and main challenges were due to communication and collaborative project management practices. The recommendations for the case company, limitations of the study, and further research topics are presented in the end of the study.

2. LITERATURE REVIEW

2.1 Complex project management

2.1.1 Project types

Companies which organize the majority of their internal and external activities through projects can be defined as project-based firms (PBF) (Artto & Kujala, 2008). A project can be defined as a unique combination of interrelated tasks which have a predefined goal, and which is restricted by time, cost and scope. There are several points of views one can take when studying a certain project. A project can be viewed as a temporary organization, product, and work structure or as tasks or as a phased process. (Artto, Martinsuo, & Kujala, 2006) For this study the focus will be in studying projects as a phased process.

On the other hand, there are different types of projects; development and delivery projects. These two types of projects are aiming for different goals. Development projects are aimed to develop the company's offering or internal processes. The benefits of these projects are indirect benefits which then can be realized through delivery projects. Delivery project is a way to deliver value for the customer through solutions. The other point of view for a delivery projects is the customer's investment project. (Artto et al. 2006) There are different contractual agreements for investment projects which define the responsibilities between the customer and the supplier of the project. Some of the most common arrangements are EPC, BOT and BOO projects.

An EPC (Engineer, Procure, Construct) project is one of the most common contractual arrangement. The contractor designs and procures the needed materials, components, and subprojects to construct the solution. In return the contractor receives a fixed price and is responsible of the schedule and budget. An extension of an EPC is the EPCM (Engineer, Procure, Construct, manage) which can be called a "turnkey" project. EPCM includes additional responsibilities with the site and authorities.

BOT (Build, Operate, Transfer) is an example of a lifecycle agreement where the contractor receives the compensation in fees which the customer pays for using the solution. In the previous examples the customer is the owner of the solution but in a BOO (Build, Own, Operate) project the contractor owns the solution for the whole lifecycle and expects to receive the necessary payback during that time. (Martinsuo, 2011) On the other hand, DBOT (Design, Build, Operate, Transfer) projects include also the design of the solution.

Delivering lifecycle solutions through BOT, DBOT or BOO arrangements requires a longer commitment and additional responsibility from the contractor compared to an EPC or EPCM project. Since, the contractor receives the compensation according to the usage of the solution the point of view changes from product- or service-oriented to solution-oriented way of doing business. Additionally, these projects are often large and complex. In the next chapter project complexity is discussed.

2.1.2 Defining project complexity

Many researchers imply that the project management practices should be adapted to the complexity of a project. These practices can be related to the management style of the project manager (Shenhar, 1998); configuration of project documentation (Ruiz-Martin & Poza, 2015); or the pre-development phase of the project (Bosch-Rekveldt et al., 2011). According to the assessment of the complexity, companies can make decisions to put effort in process, stakeholder or risk management (Bosch-Rekveldt et al., 2011). For example, project management and system integration capabilities are very important in delivering CoPS. Therefore, it is important that the competences of the project manager match the degree of complexity. (Bosch-Rekveldt et al., 2011; Hobday, 2000) Next, the factors which cause project complexity and uncertainty are defined and categorized.

Baccarini (1996) defined complexity in projects as differentiation and interdependency of elements. Elements can be e.g. tasks, specialists or components. Integration between these different elements is the main task of a project manager. Integration activities include the coordination, communication, and control of a project. In their research Baccarini (1996) divided project complexity attributes between technical and organizational complexities by studying several construction projects. On the other hand, Bosch-Rekveldt et al. (2011) added a third category to their framework for large engineering projects to characterize project complexity in. The TOE (Technical, Organizational, and Environmental) framework was built based on a literature survey and empirical research from process engineering industry. By using the framework organizations can adapt the pre-development phase of a project to fit different kinds of complex engineering projects. The assessment of a project's complexity is subjective and usually based on previous experience. (Bosch-Rekveldt et al., 2011) Therefore, people with different skillsets and backgrounds might view the complexity of the same project differently.

Technological elements are usually related to “what” is done in the project whether they are goals, scope, individual tasks or related experience of the project team. Shenhar (1998) classified projects according to their system scope and technological uncertainty. System scope can be divided into three different levels which are assembly, system, and array. A system is a combination of components and subsystems. According to his research many projects have failed due to inappropriate fit of management style to the technical complexity of the project.

Organizational elements tend to answer the “how” question and include aspects such as the size of the project, resources, project team capabilities and resources and trust (Bosch-Rekveldt et al., 2011). Shenhar’s (1998) two-dimensional method for classifying projects is mainly concentrated on the technical content of the project. In their study they did not first consider the organizational implications in their method. However, they ended up including organizational structure to their variable of system scope. Project size, project variety and the interdependency are important factors contributing to project complexity. (Qureshi & Kang, 2015)

Environmental elements which create project complexity tend to answer the “who” questions. Therefore, aspects such as the different stakeholders, location and market conditions of the project fall into this category (Bosch-Rekveldt et al., 2011). CoPS projects usually involve several stakeholders in addition to the usual users, buyers, suppliers and prime contractors to system integrators, SME’s, governments, agencies, and regulators. The different stakeholders innovate together and sometimes the users and suppliers co-engineer throughout the whole production process. (Hobday, 2000) Delivering a project in a vast network of companies creates pressure on how to manage the interfaces between these subprojects (Artto et al., 2006).

Bosch-Rekveldt et al. (2011) mentioned that by conducting complexity assessments throughout the project and not just in the pre-project phase as they suggested can give a better picture of the dynamics. Dynamics can refer to the changes in the projects and they can come from all the elements previously mentioned; technical, organizational or environmental contexts and Geraldi et al. (2009) added it as an additional element in her study of project complexity.

Studying what makes a project complex can help a company to realize what kind of requirements are needed for delivering such a solution and through which kind of a process should it be delivered. Higher technological complexity can require additional capabilities or more flexibility in the design phase of the project. In the next chapter, traditional process model for projects is presented and how technological uncertainty should be taken into account in large engineering projects.

2.1.3 Process view towards projects

The results of complexity assessments can give valuable input for the project planning phase and give implication with which kind of processes challenges should be tackled. Different project management approaches and tools are suitable for different types of complexities. On this chapter we study how projects are presented as processes and how especially technical complexity can affect it.

One of the traditional ways of defining the project lifecycle are dividing it to three phases. The first one being the preparation and selling phase, second is the project execution phase and finally the use and supporting the usage phase. The second phase, execution, on the other hand can be divided to four stages; start/definition, planning, execution/control and closing. (Artto et al., 2006) Archibald (2003) on the other hand uses terms such as the concept, definition, execution and closeout phases.

Project execution activities can be divided to technical and managerial activities which are linked along the project lifecycle. The technical activities aim to connect internal and external technological knowledge to create the project outcome. The managerial activities can be seen for example supporting the technical process through decision making and data management. Other activities involved in the managerial activities are allocation, utilization and monitoring activities, coordinating with different stakeholders and managing the information flow. (Shenhar, 1998)

In large technical projects Shenhar (1998) divides between managerial and technical process in project management. The technical process includes the product concept selection and configuration; design unit engineering and the building and testing activities as some of the examples. A simplified picture of the technical engineering process can be seen in the Figure 2 below.

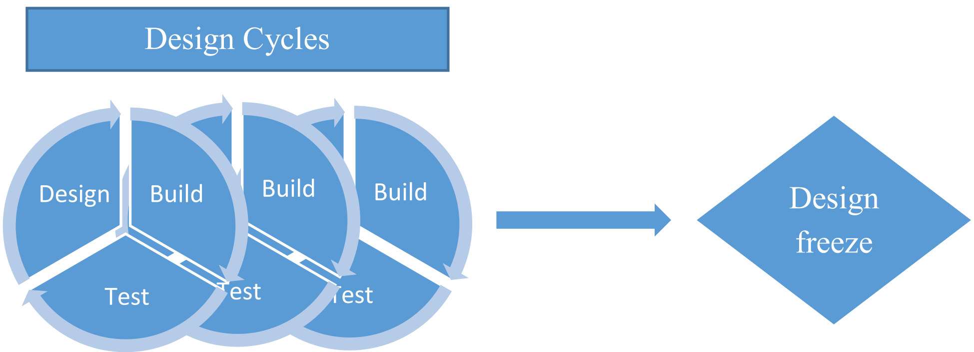

Figure 2. *Technical Process (According to Shenhar 1998)*

Some engineering projects require several iterations between the designing, building and testing. These iterations are called design cycles which in the end produce a design freeze. (Shenhar, 1998) Therefore, the engineering process is a process with different amounts of iterations which happen before the design freeze. According to Shenhar et al. (2002**),** the higher the technological uncertainty, the later the design freezes should occur, more flexibility should be allowed, and more communication should be used. (Shenhar et al., 2002) The different stakeholders innovate together and sometimes the users and suppliers co-engineer throughout the whole production process. (Hobday, 2000) Geraldi et al. (2009) presented a systemized change request process as one way of avoiding the chaos of changes in complex projects.

Technical complexity is an important element in large engineering projects. However, incorporating services such as financing, feasibility studies and operational services to product delivery projects can increase the complexity due to the different nature of services compared to products. In the next chapter, integrated solutions are discussed to understand which kind of requirements and challenges it brings to the process of delivering them.

2.2 Integrated solutions

2.2.1 Defining integrated solutions

The strategies to incorporate services wary between industries (Davies, 2004). Wise & Baumgartner (2000) identified four business models how companies can integrate towards providing services either by:

a) embedding services like maintenance and fault reporting;
b) providing comprehensive services such as financing or operating and maintaining a product;
c) controlling the distribution to market and/or;
d) provision of integrated solutions.

Integrated solutions (IS) are aiming to solve a specific business problem by combining products and services. (Brady et al., 2005) Solutions can be seen as processes where the provider collaborates with the customer and co-creates value in the long-term (Storbacka, 2011) or simply as advanced services (Windahl & Lakemond, 2010). There are several different types of services which can be offered by the PBF "*such as consultation, conceptual design, feasibility studies, training, maintenance, operation support and production optimization services"* (Kujala et al. 2013). However, in some cases the distinction of the service and the product is unclear due to the nature of projects itself.

Kujala et al. (2013) have presented a three-layered model to clarify the role of offered services in the solution deliveries. These three layers can be seen in the Figure 3 below.

Figure 3. Elements of a solution delivery (modified from Kujala et al. 2013)

The different levels are divided into; core project delivery; facilitating service products and the supporting service products. The intangible services and tangible products are divided from each of these layers. These three different layers combines the customer value aspect with the role of the services and products for the whole system. This model can be used to analyze the company's current offering to further see how each element contributes to the business of the PBF. Overall, the model has six different elements depending on the tangibility and the customer value they bring. (Kujala et al., 2013) These elements are further explained in the Table 1 below.

Table 1. *Explanations of the elements of a solution delivery*

(According to Kujala et al. 2013)

LAYER	PRODUCT ELEMENT	SERVICE ELEMENT
Core project delivery	Based on the core technological knowledge and resources	Enable the delivery of a functional system
Facilitating service products	Necessary for delivery of a fully functional system	Adjusting the system delivery to meet the customer-specific needs
Supporting service products	Creation of additional system functionality	Creation of additional value in customer-specific processes

The core project delivery usually builds on PBF's core technological capabilities and knowhow. On the other hand, facilitating service products are not related to the core capabilities of the company. However, they are mandatory to deliver a fully operational solution to the customer. These can be so called off-the-shelf technologies which are broadly available in the industry such as different kinds of cables or basic valves. In order to incorporate these products to the system some routine installation is needed which is a good example of a facilitating service. Facilitating service tasks are usually done by local subcontractors and they are also vital in delivering a functional solution. (Kujala et al., 2013)

Supporting services on the other hand, are not mandatory for the delivery of the solution. However, including them can noticeably increase the provided customer value by enabling remote monitoring and optimization of the whole system. Combining the information gathered from multiple customers the company can provide their customers valuable information of their processes. (Kujala et al., 2013) As the technology matures the uncertainty of using it in a project decreases (Shenhar, 1998) but it also affects the combination of that technology with a service. Therefore, as the technology develops, the service product which contains the technology can move into another category (Kujala et al., 2013).

Often PBF’s do not asses the impacts of adding services to the company’s offering (Kujala et al., 2013). According to Windahl and Lakemond (2010) interdependency between suppliers and customers increase when adopting an integrated solution logic compared to a goods- or service-centered logics. These interdependencies can be related to optimization, knowledge, and operations of the processes.

2.2.2 Requirements to deliver integrated solutions

Companies which make the change towards becoming integrated solution providers need to make several changes on the way they do business as opposed to a product-centered logic. The strategy and positioning of the company, needed capabilities, organizational structures need to transform. Even until the culture and mindset on how to run the business. (Brady et al., 2005) According to Storbacka (2011) solution business should be a firm-wide initiative which requires collaborative management and increased involvement of customers. Additionally, the measurement systems put into place need to consider the cross-functional nature of the development of a solution. Therefore, the alignment between the business processes and functional objectives is very important. (Storbacka, 2011) It is important that the business processes are repeatable and are uniform enough. Therefore, it is important to codify experiences from customer-specific solutions so that the most important findings can be used again. (Davies, Brady, & Hobday, 2006)

Incorporating services to a product-centered company’s portfolio changes the business model the company operates. Brady et al. (2005) argue that according to their study there is no definitive business model for an integrated solutions provider. Instead they highlight the importance of being entrepreneurial, experimental and open-minded to thrive in being an IS provider. However, the top management needs to make the strategic decision to enter the solutions business. By making this strategic decision the alignment of all the functions is easier, even the one’s which are not customer-facing. (Storbacka, 2011) Kujala et al. (2009) on the other hand highlighted the importance of creating solution- or project-specific business models instead of one or two companywide models. The logic behind this can be seen to stem from the alignment of business logic with the customers’ business model in solution-specific projects.

PBF’s which start providing integrated solutions need to move towards a customer-centric approach rather than being product- or service-centric. Therefore, acting as an integrated solutions provider requires developing new skills or acquiring them. (Brady et al., 2005) Companies need to balance between goods- and service-logics rather than moving straight to service-dominated logic when providing integrated solutions (Windahl

& Lakemond, 2010). Therefore, focusing on the traditional triple constraint model is not enough but instead customer satisfaction is an increasingly important constraint. Companies, which are providing IS cannot expect that the customer needs and specifications are stagnant but instead need to have a dynamic approach (Brady et al., 2005). Brady et al. (2005) see that the change for integrated solutions is not merely moving from towards service- or product-centric strategies. Instead they highlight the importance to focus on being customer-centric. Therefore, Storbacka (2011) argued that organizations which deliver integrated solutions should be organized according to customer segments. By doing so the generated intelligence will accumulate and help in creating meaningful value propositions in the future. As a conclusion, to provide integrated solutions companies, need to be able to provide and develop products and services in an efficient manner but keep the customer in the center of their focus.

Capabilities development and configuration are one of the main challenges when manufacturing companies start to provide products and services which are bundled up together. (Ceci & Prencipe, 2008) Companies which want to focus on providing integrated solutions need to make a thorough analysis of their traditional strengths and capabilities to make the decision of preserving or giving up on them. (Brady et al., 2005) According to Storbacka (2011) it is important to create a solution platform which supports the commercialization and industrialization of solutions. The solution platform includes strategy, management systems and supporting infrastructure. The supporting infrastructure includes for example ICT (information and communications technology) and human resources. The challenge in getting the necessary investments to build these solution platform capabilities is that they are not visible to the customers. (Storbacka, 2011)

The capabilities needed to become an integrated solution provider include;

1. Systems integration capabilities;
2. Operational service capabilities;
3. Business consulting capabilities; and
4. Financing capabilities.

(Brady et al., 2005)

Several authors of innovation research have noticed a trend where companies outsource and vertically disintegrate in the value stream to focus on systems integration as a core activity. (Davies, 2004; Rothwell, 1992) Systems integration in the broadest sense can be defined as *"the capabilities which enable firms, government agencies, regulators, and a range of actors to define and combine together all the necessary inputs for a* *system and agree on a path of future systems development."* (Hobday et al., 2005). These inputs can be e.g. software, hardware or services. According to five case studies in the IT sector Ceci & Prencipe (2008) concluded that the complexity of a software solution is the most important factor influencing strategic decisions. Thus, the customer's needs are linked straight to the needed capability configurations and firms working on the same sector can have several possibilities on how to differentiate through building different kinds of combinations of capabilities.

Companies focused on systems integration outsource the detailed design and manufacturing of components and subsystems to suppliers and contract manufacturers. The focus therefore is on coordinating the suppliers. However, system integrators do more than merely assemble products. They are key players in integrating them together for a finished product. (Davies, 2004) A narrowed definition encompasses the way of how a firm is capable of bringing together all the material and immaterial resources together with other suppliers in order to produce a product (Hobday et al., 2005). However, Davies (2004) adds that the key role of a system integrator is to internally develop the technological knowledge in order to develop future generations of products.

The significance of the systems integration grows with higher complexity, technology and costs. Therefore, Hobday et al. (2005) argue that systems integration is more than merely a technical or operational task but rather a core capability of several high technology companies. Rothwell (1992) on the other hand, saw the innovation potential in systems integration combined with a networking model. Privatization of public systems is an important factor opening new markets for system integrators. For example, in privatization has occurred in several fields including the gas supply industry. Therefore, Hobday et al. (2005) raised the importance in studying how successful system integrators have been in moving downstream to provide services to these industries which have previously been managed by the public sector.

By developing systems integration capabilities high-technology companies can move their way up- and downstream in the value chain. This can be done by using vertical integration and disintegration for the right customer segments. (Hobday et al., 2005) Managing the subsystem suppliers and networks the companies do not need to produce everything in-house. However, this requires developing system integration skills and developing the organization towards that role. (Hobday et al., 2005) Rothwell (1992) also emphasized linkages with leading edge customer and focusing on time and quality issues in development. According to Rothwell (1992) the key for doing this would be using linked software systems to do parallel development across organizations. This requires a strong horizontal linkage also in marketing with partner companies. Taking more responsibility on larger systems and integrating them together companies need to develop technical integration skills to successfully bring the project to end. (Hobday et al., 2005) On one case example from Shenhar (1998) a system integrator did not take into account the complexity of integrating systems together which led to overtime and use of external resources.

The company which has been granted the BOT project has the primary financial responsibility together with the project sponsors, insurers, and lenders. There are many features which bring difficulties such as the number of stakeholders, the relationships between them, conflicting interests and the long period of the projects. Therefore, a proper financial risk analysis is important to mitigate the possible negative effects. (Xenidis & Angelides, 2005) The risk profile of the provider changes when delivering solutions instead of products. This is due to the responsibility of the customer's processes and increased balance sheet exposure while retaining the ownership of the solution. (Storbacka, 2011) Identifying and understanding the financial risks is important, irrespective of the sources of funding itself. Thus, the company can make different strategies to cope with the financial risks. (Lam, 1999)

Providing IS's brings additional risks and costs to the company due to the need of engaging more with the customers and taking on additional responsibilities. (Saarenketo et al., 2004) The responsibility while providing integrated solutions extends the relationships from mere transactions to long-term commitments. Therefore, companies need to also have coordinative capabilities to manage the relationship with both the customer and the suppliers. Additionally, embedded service technologies need to be developed to facilitate the cooperation and provision of solutions. (Ceci & Prencipe, 2008)

Learning from projects is a good way of building new capabilities (Brady & Davies, 2004). Intelligence accumulates after some successful solution deliveries. This enables the standardization of elements and tools which help in producing those solutions. Finally, a systematic monitoring can be measured according to different customer segments and comparison between different segment organizations is possible. One important supporting infrastructure besides the human resources are the information and communications technology tools. (Storbacka, 2011)

Adding services to product-centric project deliveries affects several aspects of the PBF's business. According to Kujala et al. (2013) services affect; the strategy, sales and marketing, project implementation, learning and innovation, and financial aspects. Moreover, one service can contribute favorably to more than one of the mentioned five aspects. However, to reap the benefits, the organizational arrangements need to be considered. For example, to have the benefits for project sales activities the sales managers and service engineers need to concentrate on the knowledge transfer between these two entities. (Kujala et al., 2013)

2.2.3 Process of delivering integrated solutions

In integrated solution projects the timescale of the project is extended compared to a traditional product delivery project. Therefore, it is important to include the pre-bid stage up until the operational phase of the system. (Brady et al., 2005) The integrated solutions lifecycle as a process can be seen in the Figure 4 below.

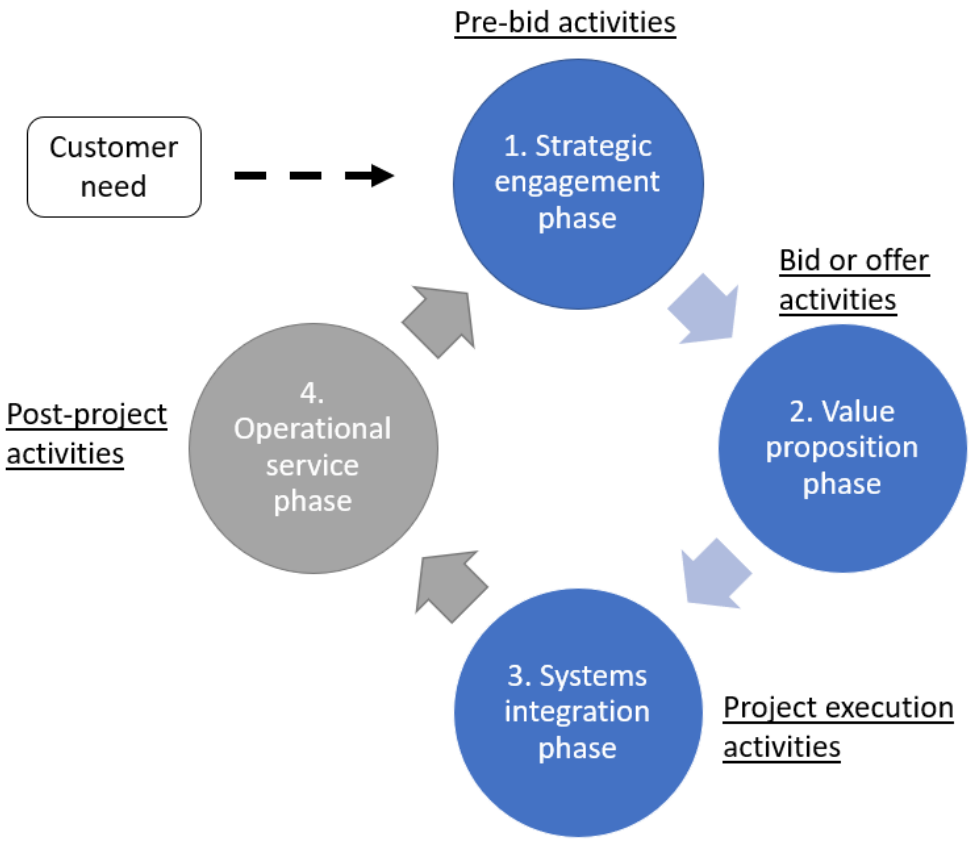

Figure 4. *The integrated solutions lifecycle (according to Brady et al. 2005)*

First a customer need is noticed, and the strategic engagement phase begins. In the strategic engagement phase the senior level representatives of the companies discuss about enhancing existing business operations or even how to open new markets together. On this phase high-level consulting capabilities are needed, and these discussions are often done before any official tenders have been asked. (Brady et al. 2005) By taking part into the early discussions of developing the solution some synergies can be gained. For example, in a case study which compared five power plant deliveries of a single firm this was noted. One of these delivery projects could be defined as a life-cycle -led solution where the provider had a special role in developing it. The life-cycle led solution was among of the most successful of the five in performance. The 'development solution', as they called the project, was able to use synergies due to early involvement in developing the plant's business case for the customer. Therefore, the offering was integrated, and it was possible to offer the customer pricing according to the life-cycle cost (€/MWh). (Kujala et al., 2010)

In the value proposition phase the company is putting together a bid or an offer depending of the situation. By creating long-term, strategic partnerships with the customers the IS providers are aiming to reduce competitive biddings which can be very costly and making offers. To build the value proposition there needs to be representatives from sales, technical design and project management. According to Saarenketo (2014) the delegation of engaging with the customers should not be handled with just one function e.g. the sales. This multi-skilled team will make a tailored proposition which meets or even exceeds the expectations of the customer.

The systems integration phase starts after signing the contract. Then a project organization will be established to implement the solution. Traditional project management skills are needed to manage the design, integration and testing of the system before the handover to the customer. In addition to the triple constraint however, project managers need to consider customer satisfaction. (Brady et al. 2005) After the project execution comes the operational service phase where the company operates and maintains the solution. The systems integrator can receive valuable feedback from the services provided in maintaining the system (Hobday et al., 2005). While providing operation and management services the company can also notice when the customer could need an upgrade to the existing solution which can then start a new integrated solution project. Therefore, the optimal process of delivering integrated solutions is a closed loop which can be seen in the previous Figure 4 where the companies form long-term, strategic partnerships and deliver several projects. This would support Storbacka's (2011) view of solutions being a continuous process where the provider co-creates value with the customer in the long-term.

Davies (2004) on the other hand studied the supporting service actions in delivering capital goods. These supporting services provide value for the main stages of the project by providing input and support all along the project as seen in the Figure 5 below.

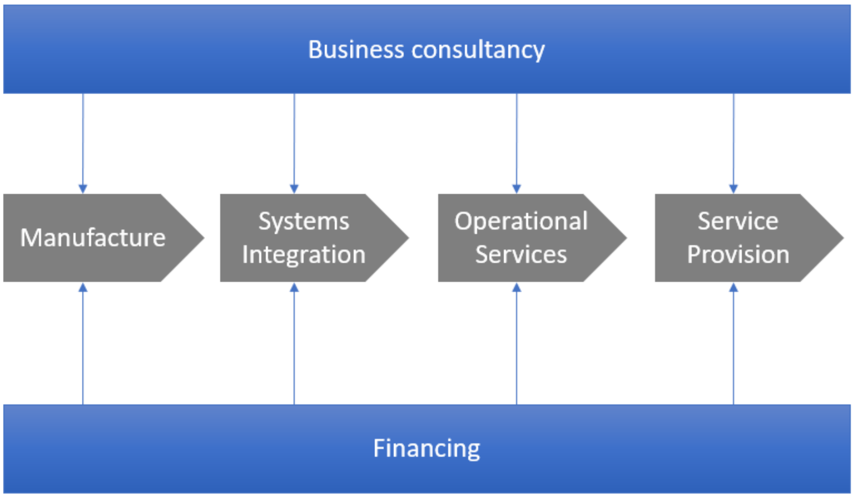

Figure 5. Supporting service actions in capital goods (According to Davies 2004)

Business consulting and offering financial services can also be a supporting service rather than a capability needed in just one phase of an integrated solution delivery. However, in Davies (2004) model they're seen as actions which support delivering capital goods on each of the phases through manufacturing, integrating the systems together, operating them and providing other services.

Offering financial services might bring the company projects which haven't been possible before. This is due to the possibility of offering value-sharing contracts with the customers which lowers the initial purchase price of the product and but creates additional revenue to the company in the shared profits in the operational phase. (Davies, 2004) ABB founded their financial service division which enables them to serve their customers better and to have the opportunity to be included in the strategic discussions during the negotiation phase of the solution. It has helped the company to gain competitive advantage compared to their competitor which can outbid them by price. (Slywotzky, Morrison, & Andelman, 2007)

Companies offering integrated solutions have the possibility of insourcing, outsourcing or leveraging the capabilities of a partner company and suppliers. Coordinating decisions, involving the buyer, and matching the financial and technical resources are key tasks to combine the expertise and resources of different collaborators. The prime contractors and systems integrators usually form temporary multi-firm alliances with the users in CoPS projects. (Hobday, 2000) This can be done through formal or informal collaboration which is discussed in the next chapter.

2.3 Interfirm collaboration in complex projects

2.3.1 Defining interfirm collaboration

Interfirm collaboration is one way for SMEs to level the playing field against large companies. It was first noted in Western Europe where the third sector have been trying to support SMEs with policies which would accelerate collaboration and forming of manufacturing networks. (Rosenfeld, 1996) Especially, with limited resources and market presence the benefits of collaboration are great. (BarNir & Smith, 2002) emphasized the importance for a small firm to have these opportunities to collaborate. Outmatching a larger competitor, entering new markets and having access to valuable resources, are the most important benefits for a small firm. This may be due to concrete operational benefits such as cost sharing or transferring different technologies between partners (BarNir & Smith, 2002).

Collaboration can take various forms such as an alliance, partnership, joint venture or eco-system (Hawkins & Little, 2011b). The number of alliances formed has been growing rapidly since 1975 in high-technology industries such as information technology, biotechnology, chemicals and aircraft. In the biotechnology industry between 1980 and 1990 there were 40 to 140 alliances made annually in the industry. (Benjamin Gomes-Casseres, 1996) Hence it is important to study how SMEs can deliver integrated solutions which are usually done by large companies with vast resources and manufacturing networks. Schermerhorn Jr (1975) defined interfirm cooperation as *"the presence of deliberate relations between otherwise autonomous organizations for the joint accomplishment of individual operating goals"*. BarNir & Smith (2002) used this definition to also describe interfirm alliances.

Especially in high-risk, high value investments approaches which encourage collaborative working may give substantial benefits. These are for example alliancing and the ISO 44001 standards. Alliancing is one example of a formal agreement which is put to place to achieve a common goal. (Ward, 2017) While studying the construction industry in the United Kingdom Burton & Gameson (2017) found out six different key factors which are important for a successful alliance. These are satisfaction and value, appropriate investment strategy, appropriate legal agreements, appropriately shared risk management, improved performance and competitive advantage. Offsite manufacturing and sufficiently developed technological advancements were also highlighted in the literature, however not supported while empirically testing the framework.

Networks can be defined as more than two firms cooperating to gain competitive advantage over other firms. This can be done by solving problems together, developing and producing products or entering new markets. (Gelsing, 1992) Networks can be classified to ‘hard’ or ‘soft’. The ‘hard’ networks usually have a clear objective such as product or market development. Thus, they usually require a formal cooperative or joint business arrangements. On the other hand, ‘soft’ networks tend to be more general in their objectives such as supporting each other by sharing information and acquiring new skills. These often remain informal in their nature. (Rosenfeld, 1996) In order to form these networks or constellations firms link together by series of strategic alliances. (Benjamin Gomes-Casseres, 1996)

Increased collaboration can enhance project performance by increasing the organizational capabilities (Du et al., 2016). These are for example the financing, operational, systems integration and business consultation capabilities discussed in the previous chapters. Joint ventures are ways of formally integrating together not only by agreement but aligned business opportunities through shared profits in business endeavors. For example, a large telecom company named Cable & Wireless provides their corporate customers consultation by partnering with Accenture rather than building and producing those capabilities in-house. (Davies et al., 2006)

Providing integrated solutions requires intensive, long-term collaboration also with the customers. Therefore, several organizational units will be taking care of the value-adding activities inside the PBF. Artto, Valtakoski, & Kärki (2015) noticed that therefore, it is important to analyze where and when the customer is served throughout the lifetime and ensure that these marketing activities are integrated across different organizational units such as the project and service organizations. In their research they identified eight different mechanisms on how projects and service units can participate together in system deliveries. However, these units might not be inside one firm but instead across firms. The systems integrator can get help from contractors which offer services such as technical consultancy, design, engineering and project management (Davies, 2004). Cross-organizational engineering teams and integrative persons are important aspects while integrating a supplier while providing CoPS. Integration requires active effort by creating roles, events, and tools even though contractual commitments are in place. (Martinsuo & Ahola, 2010).

One of the main tasks of procurement is to make the decision of whether to produce in-house, outsource or collaborate. (Hobday et al., 2005) argue that the systems integration capabilities of a company are linked into those decisions. These are strategical decisions which also affect the company’s position in the value stream. However, according to Martinsuo & Ahola (2010) research on project procurement practices has been centered in identifying suppliers and managing the project risks and responsibilities through contracts. There are differences in how to integrate suppliers to the project execution which might affect the project results. Therefore, (Martinsuo & Ahola, 2010) studied two different ways on how to integrate suppliers in complex systems project management. These different ways were further categorized into one which enhance control or emphasize cooperation. Martinsuo & Ahola (2010) suggested that controlling and cooperation-oriented integration mechanisms should be used complementarily. They found out that commitment and temporal duration of the relationship could be factors affecting whether to focus on controlling versus cooperative mechanisms.

2.3.2 Benefits and challenges of interfirm collaboration

The challenge in studying the interfirm collaboration of SMEs which are also PBFs is the lack of studies. There are studies concentrated which list the interfirm collaboration but usually it is either in the context of large companies or SME manufacturing networks. The benefits and challenges of some of the studies are summarized in Table 2 below.

Table 2. *Benefits and challenges of interfirm collaboration in different contexts*

Author	**Context and method**	**Benefits**	**Challenges**
Hellgren & Stjernberg, 1995	Design of large construction projects		Short- and long-term optimization, trying to behave rationally, difficulty in assessing long-term effects of decisions
Rosenfeld, 1996	SME, manufacturing networks	Improvements in sales, increase in productivity and reduced operating costs.	
BarNir & Smith, 2002	SME, manufacturing companies	Outmatching a larger competitor, entering new markets and having access to valuable resources.	
Davies et al. 2006	Five large PBF companies.	Sharing integrated solution capabilities.	
Tikkanen et al., 2007	Companies of all sizes. International architecture and power plant projects.	Acquisition of subsequent projects	
Du et al. 2016	Survey study of the 51 largest, Chinese contractors.	Increasing the organizational capabilities	

Economy which consists of interdependent and complimentary alliances enables the creation of alternative business models with a more holistic value chain (Hawkins & Little, 2011a). There are also substantial strategic benefits to collaborating. Collaboration may help organizations also moving to new markets. Especially in SMEs the resources and knowledge inside the company can be scarce. In the evolutionary knowledge management model for internationalization Saarenketo et al. (2004) list "*integration and transfer of different knowledge-bases through partnerships and generic knowledge"* as the external way of acquiring knowledge and enhancing performance eventually through the development of competitive advantage. Therefore, partnerships are an important way to accumulate knowledge to the company. Partnerships and network relationships are ways of gaining knowledge which is not generic. (Saarenketo et al., 2004) Thus, a PBF could learn faster before making the mistakes itself in the projects.

Partnering with different stakeholders can give various benefits also for the delivery of CoPS projects by for example managing risks more efficiently together (Du et al., 2016). Robson & Bennett (2000) presented a multivariate analysis of how acquiring external business advice through collaboration between international or local suppliers and government-backed providers. Collaboration in the supply chain was found to be the only significant aspect for SME performance. There were differences also inside the supply chain collaboration. Collaboration with the international/national suppliers seemed to indicate greater volumes in turnover and employment. On the other hand, collaboration with local suppliers led to higher profitability. Higher profitability was supposed to be due to either reduced prices or successful delivery of higher value in products or services thus leading to higher profits. (Robson & Bennett, 2000)

Temporary and project-based settings bring additional challenges for interfirm collaboration. Especially so, if the organizations have not worked together before. Indeed, the Financial Times (2016) named a *"conflict emerging between consortium partners who have not co-operated before"* as one of the biggest risks in large engineering projects. Successful collaboration requires investing into integrative measures. The risk in not investing to building the collaboration is failure and counterproductive results in the long-term. Therefore, existing business processes need to be remodeled to consider the partners. (Hawkins & Little, 2011b)

Besides of the right collaboration practices it is a challenge to even find the right, non-opportunistic partner to collaborate with (Saarenketo et al., 2004). A challenge for especially small companies seeking to partner with other companies is how to make themselves a desirable partner to collaborate with. Characteristics, which make a company desirable to partner with, are for example "*financial resources, technological* *knowhow, market position and unique human resources"*. (BarNir & Smith, 2002) The partnership need to be a win-win for both of the collaborating companies for it to work out (Saarenketo et al., 2004).

Integrating business processes can create challenges if not managed properly. Therefore, organizations need to develop cross-organizational management practices which are extended over the internal boundaries of the company and likely across geographical boundaries. Managers need to rely on trust. Motivating and coordinating remote teams is also a challenge in comparison to managing co-located operations. (Hawkins & Little, 2011a) Collaborative leadership on the other hand, requires advocating the collaboration internally. Co-creation requires forgetting the hierarchical relationship, which is familiar from subcontracting and normal buyer-supplier relationships where the positioning and power of the leader enables the success. To do this, the organizational and personal approaches and goals need to be aligned in the beginning of the partnership. (Hawkins & Little, 2011a)

The opportunity to learn from partners through alliancing can enable rapid learning and help in the internationalization of company. However, there are certain challenges in acquiring knowledge in alliances. For example, the partner does not necessarily want to share their knowledge, or the information is tacit. Tacit information is silent information which is for example based on earlier experiences and connected to abilities to perform certain tasks. However, even if these challenges are met and the knowledge is made available companies do not always succeed in acquiring the knowledge. This is due to inappropriate knowledge acquisition practices and ineffective learning practices due to lack of learning connections or managerial culture. (Inkpen, 1998)

In conclusion making a partnership to work out firms need to put in substantial amount of resources and face multiple challenges. Therefore, a collaborative model should be put into place only if the collaboration can add real value compared to existing approaches. (Hawkins & Little, 2011b) In the next chapter a process model on how to incorporate a collaboration model to the lifecycle of providing integrated solution projects is presented.

2.4 Integrated solution delivery project framework

Delivering integrated solutions requires additional capabilities and resources compared to a normal EPC delivery. Therefore, especially small firms with scarce resources may benefit from collaborating with project partners with complementary capabilities. However, there are certain challenges related to interfirm collaboration, especially when working on large high-technology projects. The identified requirements to deliver integrated solutions are listed below in Table 3.

Table 3. *Requirements to deliver integrated solutions*

Requirement	**Source**
Solution-orientation	Windahl & Lakemond, 2010; Brady et al., 2005
Capabilities (e.g. financial, systems integration, business consultation and operational service)	Brady et al., 2005; Ceci & Prencipe, 2008
Supporting infrastructure (ICT and human resources)	Storbacka, 2011
Repeatable business processes	Davies, Brady, & Hobday, 2006
Solution- or project-specific business models	Kujala et al. 2009

This study concentrates on the processes of delivering integrated solutions where interfirm collaboration plays an important part. The theoretical framework is presented in the Figure 6 below where the phases of integrated solution lifecycle are combined with the phases of building a collaborative relationship with a new project partner.

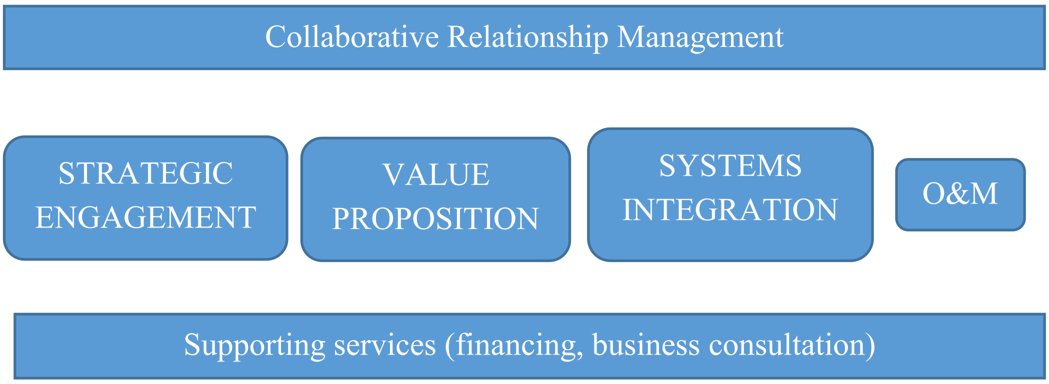

Figure 6. *Integrated solution lifecycle with supporting service action framework (According to Davies 2004, Brady et al. 2005)*

The framework above combines the integrated solution lifecycle framework of Brady et al. (2005) with the supporting service action framework of Davies (2004) In integrated solutions the lifecycle is extended from just the project execution (systems integration) phase. Some of the capabilities (financial, business consultation) identified by Brady et al. (2005) can be seen as supporting services for the integrated solution deliveries as depicted by Davies (2004).

The current literature of delivering integrated solutions has been mainly concentrated on large companies as noted in the literature review. One hypothesis in the beginning of the study was that for an SME the collaboration with project partners could be especially important since a smaller company would not necessarily have all the requirements needed to deliver an integrated solution. Thus, an addition to the framework was made to include collaborative relationship management as one of the supporting services.

3. RESEARCH METHODOLOGY

3.1 Nature of the research

Constructive research was chosen for the research approach of this study. Constructive approach is a good way to solve both operational and theoretical problems by creating different constructs in forms of models and diagrams. Multiple, qualitative data gathering methods were used to build the construct. By mixing multiple methods to gather data helps in validating the results and in this case to have different perspectives for the case study. (Oyegoke, 2011)

The empirical part of this research is based on a case study conducted in a project-based firm. Taking an operational process view is one of Shenhar and Dvir's (2007) suggested ways on conduct project management research in a problem-driven way. Other views are the strategic business view and team leadership view. This study uses an abductive approach, meaning that there was a constant interplay between the inductive and deductive approaches.

Constructs are good for solving operational and theoretical problems. In the previous chapter the theoretical construct was presented. This construct is general and describes the main phases of integrated solutions deliveries with some supporting services. However, the empirical construct is aimed to be more detailed in describing the necessary tasks done in each phase. The need for this study begun with the case company's need to have a clearer view of their projects. Two aspects rose as the most important operational challenges to be met. The first one was the lack of milestones in the case company's projects. The projects were managed by lists of sequential tasks as seen in Appendix B which were then transformed into Gantt charts. The other challenge was to understand the project flow between the two different organizations in project A. The change from sales to the case company's engineering team and back to the partner company's engineering teams. Therefore, a swim lane process model was chosen to be appropriate to analyze which tasks are done by whom, when and what are the necessary milestone points for the projects. This is also beneficial for the research of operations management literature in project management. Further information of the building of the construction in the next chapter 3.3. Research Process. Next, more about the different types of delivery projects in the case company.

3.2 Case projects

The delivery projects of the case company could be divided according to the scope of the project two different types; system deliveries (EPC) or lifecycle solutions (DBOT). Project A represents type 2 and project B type 1. Project A was the main project for this study. Mainly because it was the most developed of the company's projects and it represented the largest in scope. Project B was studied to get some cross-case comparison and to help in understanding how the requirements change by the scope of the project.

On this paper Shenhar's system level is appropriate to link with literature of CoPS (Complex Products and Systems). The level of technical complexity according to the Head of Engineering: "*With the [Case company's] product and with one strategical system [project A] is high-tech - - as a whole.*" Both projects can therefore be classified as high-technology, system level projects.

In project A the case company is the DBOT provider and responsible of the design and financing of the whole plant. The project partner delivers engineering and consultation services to the case company and they have been granted the general operations and management contract for the power plant. There is also a consultant who offers consultation services for permitting and local sourcing.

In project B the customer for the project is the EPCM contractor for the whole project and the direct customer for the case company. On this project the EPCM customer is the project partner for the case company. The collaboration between these two organizations had begun earlier with planning of a previous project in another location. The EPCM contractor handles stakeholder relations and the development phase which includes for example studies on the different biomass materials and taking care of the financing for the project. There is also a service provider which is providing detail engineering services for the case company.

As we can see the roles in partnerships in the projects A and B are reversed. On project A the project partner is a service provider and in project B it is the project customer. Also, the customer segments are different. For the project A the end-customer is a private entity and for the project B it is public sector customer. In the project B the customer is actively sharing information and helping in the permitting process which is handled by the project partner. In the project A on the other hand the case company handles the permitting with the support of a local partner.

3.3 Research process

The research process can be seen in the Figure 7 below. There were two major induction-deduction loops in the research process which can be seen marked with blue shapes and arrows. On the other hand, the constructions of the research process can be seen on the edges. The focus of the study was mainly on one project. However, data was gathered also from a second project to have a different perspective and be able to compare the case projects with each other.

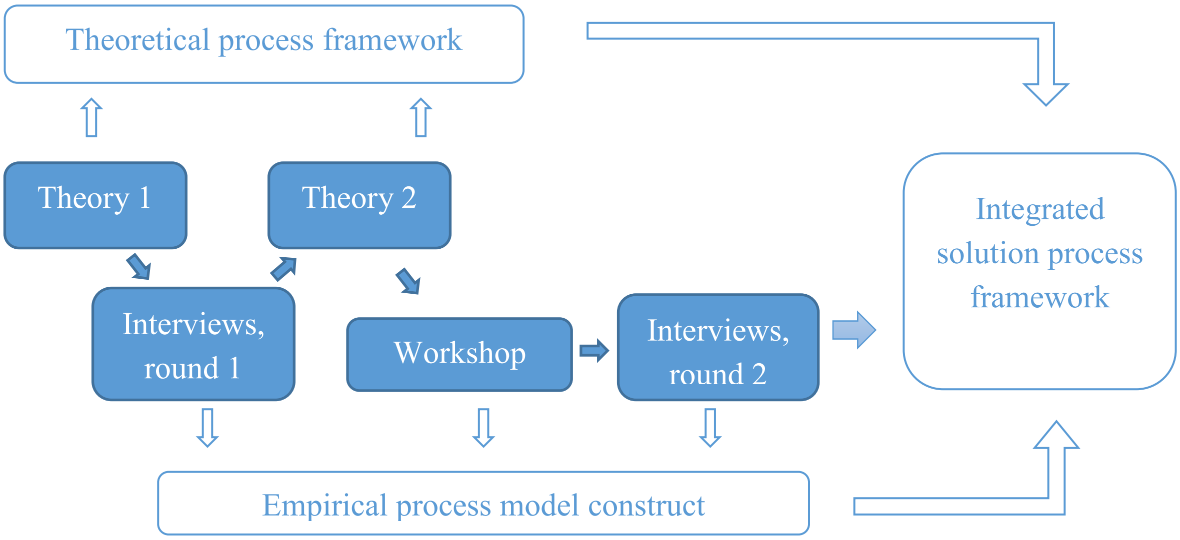

Figure 7. *The research process*

The research setting begun with analyzing the complex project management theory on theory 1 and then gathering information of the current situation in the company with the first interview round. Two research questions, which addressed relevant issues in the company but also would add on existing theory of project management were chosen during this first research loop and the building of the theoretical process framework began.

Semi-structured interviews were used to help in building a view of operational processes in the company's projects. The information was coded into an empirical process model which was tested in the workshop along with some results from the interviews. In the second interview round some additional interviews were made to study further the collaboration between the project partners in the projects, to fill in some of the gaps in the empirical process model construct. Finally, the two constructs were combined into an integrated solution process framework which is the main result of this study. The constructs also supported the case company in their practical problems, since a process model has codified information on how to deliver integrated solutions and serves as a foundation for project quality management.

During the research process the theoretical framework was built and aimed to answer the two research questions. The first question is a “what” -question and the second one is a “how” -question. The what -part of the study are the empirical chapters 2.1. Complex Project Management and especially 2.2. Integrated Solutions which is aimed to define integrated solutions and to understand what is needed to deliver them, especially for an SME. After this, interfirm-collaboration was found out to be especially important in this type of a setting.

On this study the project is seen as tasks which form a phased process. Usually a Gantt chart is used to show the project management plan in a timescale where interrelated work packages are shown. However, in large complex projects, there are many interrelated work packages and tasks which require similar kinds of activities such as design and engineering work or bidding for parts. Therefore, in this study a swim lane process model was constructed to visualize the project phases in a different way. This way a process model could serve as a tool for project communication and collaboration between the project partners and stakeholders in the project network opposed to a Gantt chart where there is difficult to show several different organizations or project members with different roles. Also, the process model offered a more detailed view on the process of delivering integrated solutions in this type of a setting where the systems integrator is depending on the project partner.

3.4 Interview data collection and analysis

Semi-structured interviews have a common theme and a list of questions. However, compared to a structured interview the researcher can leave some questions unanswered and ask additional questions according to the flow of the interview. Therefore, semi-structured interviews are good ways for explorative research and building new theory as opposed to strictly testing existing theory. The interview frame can be found in the Appendix A. The aim for the semi-structured interviews was to identify some of the challenges in the two different project types and to start building the process models for them.

The interviewees chosen for the interviews were mainly personnel working for the case company and especially to the projects A and B. Additionally three persons were interviewed. A consultant to get a better understanding on the previous work on the process model development and in the later stages two members of the project A’s collaboration partner employees to validate the project process model construct but also to get information on the interfirm collaboration between the partners.

The interviewee information including the interview number, interviewee-id, position, represented organization, project and duration of the interview can be found below in Table 4. The CC meaning the case company and PSU is Project services unit.

Table 4. *Interviewee information*

Interview number	**Interviewee-id**	**Position**	**Organization**	**Project**	**Duration (min:ss)**
1	1	IT consultant	Consultant	General	29:49
2	2	Project Manager 1	CC PSU	A + B	12:26
3	3	Sourcing Engineer	Consultant	A	95
4	4	Process Engineer 1	CC PSU	A + B	62:26
5	5	Process Engineer 2	CC PSU	A+ B	36:47
6	6	R&D Engineer	CC PSU	General	19:54
7	7	Head of Engineering	CC PSU	A + B	44:37
8	8	Head of regional business unit 1	CC Business unit A	A	68:06
9	9	Head of R&D	CC PSU	A + B	60:41
10	10	Project Developer	Project Partner A	A	76:50
11	7	Head of Engineering	CC PSU	A	40
12	11	Head of regional business unit 2	CC Business unit B	B	61:35

Interview number	Intervie wee-id	Position	Organization	Project	Duration (min:ss)
13	3	Sourcing Engineer	CC PSU	A + B	61:44
14	2	Project Manager	CC PSU	A + B	33:58
15	10	Project developer	Project Partner A	A	26:41
16	12	Project Manager 2	Project Partner A	A	59:50
17	13	Sourcing Manager	CC PSU	A	47:02

The interviewees presented different positions in the company to build the whole picture of the process model. Most of the interviews were conducted face-to-face but some were also conducted through Skype. The data from the interviews was documented by making notes during the interview and all the interviews were recorded. The most important parts of the interviews were transcribed to text format. The length of the interviews varied from 12:26 to 95 minutes.

The questions in the first interview round consisted of general and project specific questions. The general questions helped to get a better understanding of the projects and finding the requirements of providing integrated solutions. Questions concentrated on describing the task flow helped to build the process model construct. Since the interviewees had different roles in the projects the process models were constructed as somewhat separate pieces and the workshop served to verify the linkages between the different tasks.

3.5 Workshop data collection and data analysis

In addition to the interviews a two-day workshop was organized on 15th and 16th of August. There were 15 attendants in the workshop who were all from inside the organization. The project partners were not included in the workshop. Also, some employees who attended were not part of the interview process. This was because some were not part of the core project team but instead from supporting services such as research and development or human resources. Some of the attendees had therefore never worked together before. The attendees were divided into three groups of five people. The groups were formed so representatives from different roles of the process would be present. The workshops were organized in the facilities of the case company.

The agenda for the workshops can be seen below in the Table 5. In the workshops the thesis worker facilitated the workshop by first presenting the results of the interviews and opening the discussion of the different themes first and then taking notes of the answers for specific questions or observing the conversation in the groups.

Table 5. *Workshop agenda*

Day 1	Themes	Day 2	Themes
8:30-9:00	Starting the day by presenting the agenda and objectives for the workshop	8:30-9:00	Starting the day by presenting the agenda and objectives for the workshop.
9:00-11:00	Presenting the interview findings Checking and evaluating the process models (30 min) Task inputs and outputs (15 min) Project partner collaboration (15min) Project milestones and decision-making points (15 min)	9:00-12:00	Project types (EPC/DBOT/Tech) (15 min) Project goals and limitations (15min) Building the integrated solution process framework in groups (1,5 hours + breaks)
	Lunch		Lunch
	--	13:00-15:00	Reviewing the workshop findings Evaluating the requirements for supporting IT systems (IT consultant)

The goal of the workshop was to validate findings made in the interview round 1, test the process model which was constructed and to create a new integrated solution process framework. One of the reasons to invite the whole company for the workshop was to help everyone understand the different project types and their role in them. Also, the interfirm collaboration between the project partners was discussed. The themes of the workshop can be divided into;

1) Checking and evaluating the empirical process models (project A and B)
2) General discussion of project milestones, goals, and development ideas
3) Discussion of interfirm collaboration in project A and B
4) Creating an integrated solution project framework where the information inputs and outputs of each task are clearly stated.

On the first phase, the three different groups studied the process models of project A and B. The groups made final corrections to the process models and in the end of day 1 the process models were revised and updated. These final versions of the process model were then used on day 2 as basis for creating the future model for the integrated solution process model which is the phase 4 in the list above. Besides confirming the process models and creating the integrated solution project framework, on phases 2 and 3 there was more general discussion of the basic principles of project management, differences between EPC and DBOT project types and how the engineering services unit has experienced the collaboration with the project partner in project A. Alson other data sources were used in addition to the workshop and semi-structured interviews. Other empirical data sources can be seen in the Table 6 below.

Table 6. *Other empirical data sources*

Data Content	Data type	Source type
Observations from project meetings	Speech written to own notes	Primary
Case company meeting notes	Meeting notes in text format (e-mail, word)	Secondary
Process models done in the previous IT project process workshops	PowerPoints with flow charts of operative processes	Secondary

Other empirical data was gathered through observing project meetings, reading old meetings notes and going through material from previous process development workshops. Primary data gathered through observing from the project meetings enabled to explore the challenges in the interfirm collaboration. Secondary sources, such as meeting notes and old process models were used to create the foundation of understanding of the company's product, strategy and current state of process development.

Next, the results of these combined data gathering methods are presented in chapter 4. The results are presented in the order of how the data was gathered. The chapter 4 presents first a general overview of the case company's projects and views from the different roles in the company. Second, the project A and B are described. The focus is the project development and the design process phases. Third, results of the interfirm collaboration during these projects, especially in project A are presented and finally the integrated solution framework is presented.

4. RESULTS

4.1 General overview of the case company's projects

An IT consultant was interviewed to establish a first impression of the process development phase in the company. Therefore, questions were mainly related to the previous process development workshops and their conclusions. A general process map had been done with four phases; marketing, bid management, implementation and operate. Below in Figures 8, 9 and 10 these phases are presented until the construction phase since this study is focused on the pre-project, design, engineering and procurement phases of the projects.

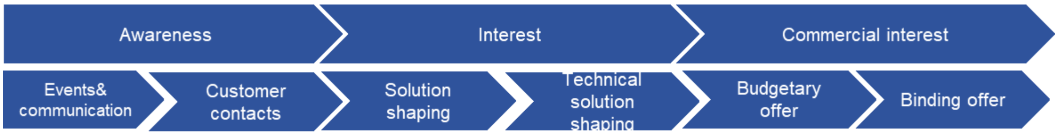

Figure 8. *Marketing/Sales process*

Here, the marketing of the company's solutions starts with getting customer leads in different events or through other sorts of communication for an initial analysis of the customer needs and to estimate the economic potential of a possible project. After that, the required outputs or products are defined, and the requirements of the environment are checked during the technical solution shaping. When the commercial interest of both parties is confirmed, the case company starts to work on budgetary and binding offers. In the Figure 9 we can see the bid management phase where the steps leading to the binding offer can already be found from the marketing/sales process but additionally there are the basic engineering, detailed engineering and offer creation tasks.

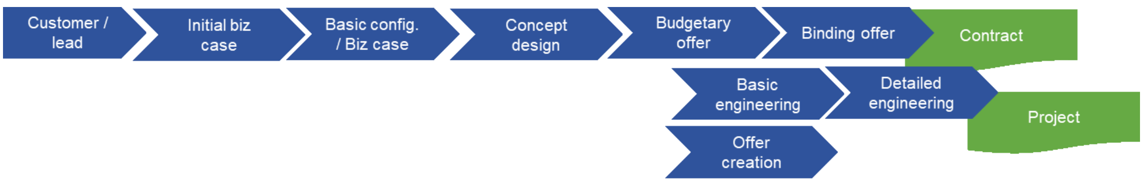

Figure 9. *Bid management*

The basic engineering and detailed engineering run parallel and support the offer creation. On this process map the project task means the beginning of the project execution phase where the customer specifications are narrowed down, and the contract has been signed. However, it is a bit conflicting with the Figure 10 which can be seen below.

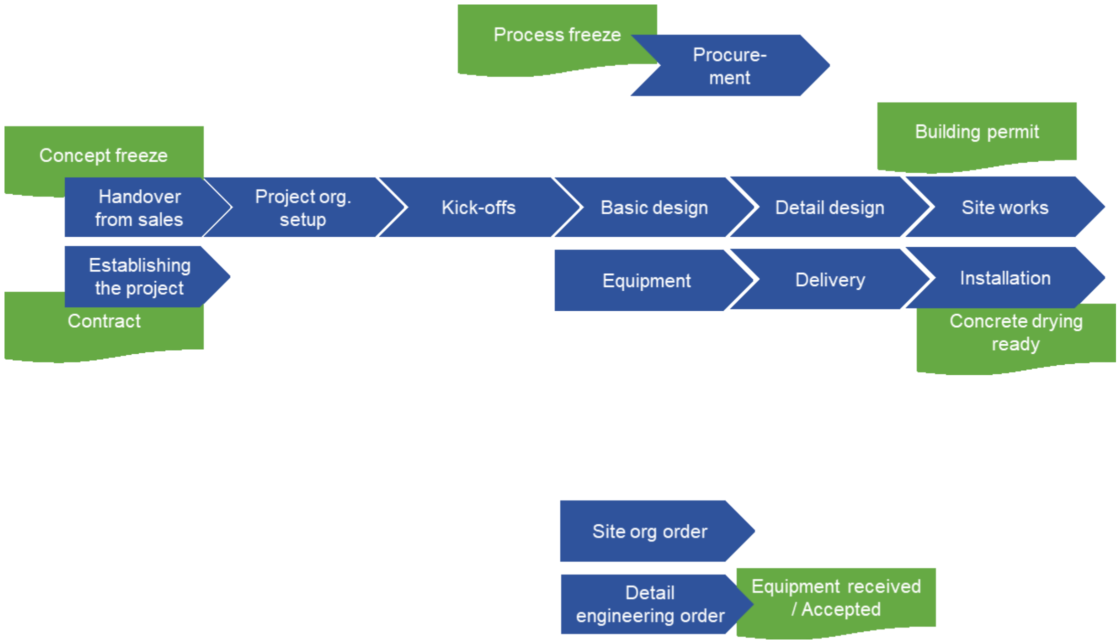

Figure 10. *Project implementation*

In the project implementation phase the project is established after receiving the contract and the concept has been locked in the concept freeze phase. After the project organization has been setup and the project has been kicked-off there are basic and detailed design tasks. The process freeze starts the procurement of the project, but it is not clearly stated after which task the process freeze happens. Also, the detail engineering order is not linked to the task flow. As mentioned, these were the first drafts of process models for the company and none of the projects had yet properly started so that these could have been validated. Therefore, in the interviews which followed these process models were not used as a basis but rather they brought up the challenges in the current state of project management.

According to the project manager the project work packages could be divided into permitting, basic design, detail design, procurement, installation, receiving of ordered materials to the site, construction, commissioning, testing and performance review. From these the critical tasks for the project were the permitting, long lead time components and commissioning. Signing the sales contract, finishing the design phase, and permitting could be seen as mileposts in the projects.

When asked for a general description of the projects the project manager divided them to plant deliveries and technology add-on projects. The project manager described the projects as similar due to the case company's core technology which was to be delivered in these projects. However, the team members who are responsible of the marketing, sales and development of the projects tend to see the project A and B in a very different way. They highlight the differences between the projects due to cultural differences, customer types or how the project has been developed.

"For an engineer a project is an engineering job which has a specific schedule and specific set of requirements and tasks and duties and you can put prizes on it and you can put deadlines on it and you can figure out how many people you need in to do it and it is all very defined, right. So, that is one definition of a project. And that is one definition of project management. However, there is a larger, broader, more general definition of project management which is that we get into a point where we have a project which is a possible facility which we could develop and build." – Project partner interviewee

The differences between the different projects are not necessarily clear in the company and the projects are perceived to be quite similar with each other. Both are described to be as system or technology delivery projects rather than solution deliveries.

" The projects have similarities since the core deliverable is our own technology. Turn-key also known as EPC delivery." – Case company interviewee

Many remarks were made of the challenges in project communication either inside the case company and between the different project partners. However, the company is investing heavily on building the whole ICT infrastructure which would be fully integrated so that the information of the project will flow through each phase smoothly.

According to the earlier Figures 8-10 which offer a view to different processes which run parallelly and feed information to different tasks. There can is a separation between a pre-project phase and the project implementation phase. The contract with the customer separates these two phases from each other. In project A this pre-project phase is called as project development phase which also includes the concept design phase. The contract with the customer was not made after the concept design phase because the permitting was late and needed additional degree of design activities which would normally be done during project implementation phase.

4.2 Pre-project phase

4.2.1 Project development phase

According to the CMO of the company main differences for the company in the between the two types of project deliveries are the activities done before the offer *"the delivery* *process in the view of sales is pretty much the same in the EPC delivery as in the DBOT delivery. The main changes come before making the offer, for example when we are scanning the market for potential projects."*

Another interviewee from the sales unit of the project A described the project as a DBOT project which would derive from words *"Develop, Build, Operate and Transfer"* However, as seen in the citation the "Design" phase was replaced with "Develop". This phase was done;

"- - to help identify the project opportunity and start actualizing it, - - we call it the development stage of the project." – Case company interviewee

The goals of developing a project were for example mitigating risks to get funding for a specific project. In one interview the interviewee also separated the development work in two phases. The first development stage starts even before the potential customer has been met. The goal is to identify development opportunities from a certain market where there is for example enough raw material to use.

"- - it is not really a project yet the way how - - uses the term. Instead we maybe say it is called a development opportunity." – Project partner interviewee

After these "development opportunities" are studied for a while, a decision of their business potential is made, and they turn into development projects which get granted a small budget. Activities which happen during this development stage are mainly related to stakeholder relations and different contracts. The goal of this phase is the beginning of the construction period, so the "Build" phase of DBOT. The development stage therefore includes the "Design" stage and are intermittently used as synonyms for each other. Next the two main design tasks such as the conceptual design and basic design tasks are analyzed.

4.2.2 Design phase

According to the head of engineering the whole project A could be classified to a high-technology system delivery. The concept design has been completely updated twice and there have been 18 design iterations in the basic design phase of the power plant. This is much more than the 2-3 design iterations done for project B. As one interviewee mentioned: *"The scope of the project [A] is being tuned all the time."*

Changes to the project A have been due either to;

- Possibility to enhance the feasibility of the plant

- sourcing problems which have arisen, and
- findings made while prototyping the plant design.

Concept design

The design of the concept in project A started when the business concept was approved. The different business units which interact with the customer in the sales phase, contact the process engineers straight and ask for concept or layout designs as we can see in Figure 11.

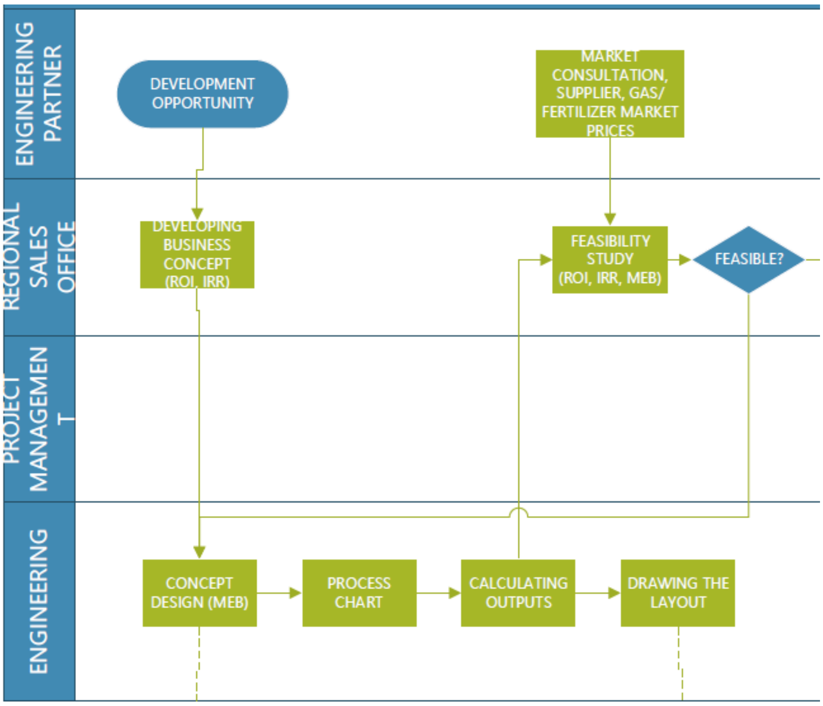

Figure 11. *Concept design tasks of project A*

This causes some projects to go forward without the knowledge of the project manager and can lead to other projects to run late due to incorrect resource allocation. However, this was corrected a few months later by hiring a person for sales support who will handle the projects in the pre-bid and bidding phases.

Another challenge in project A was the lack of customer participation in developing the concept of the plant. The concept was developed by the case company and the project partner themselves. In comparison the concept development of project B was more straightforward since the end-customer of the plant was included in the project since the beginning. The concept design phase of project B can be seen below in Figure 12.

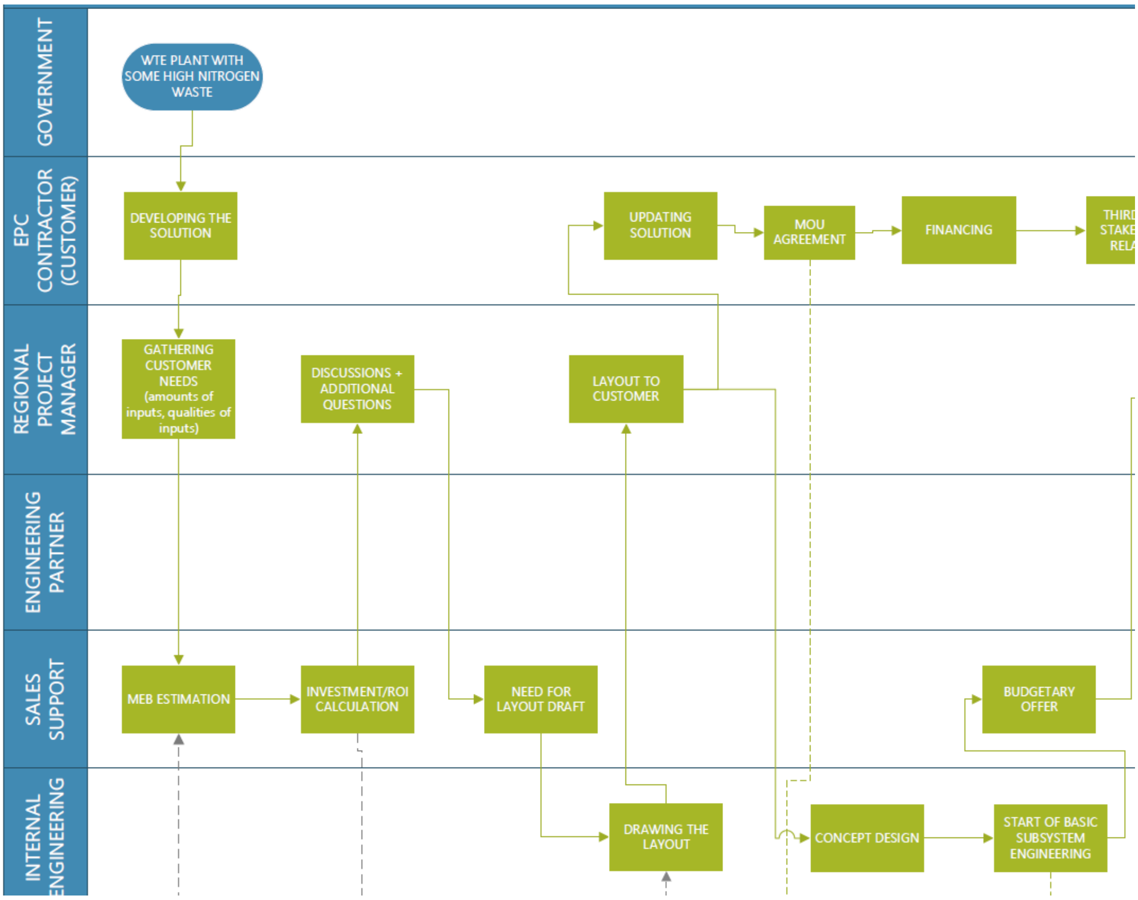

Figure 12. *Concept design phase in project B*

In project B, the end-customer gathered a team to help with permitting and designing the concept together with the EPCM contractor (project partner B) and the case company. The concept design phase of the project B has been quite straightforward. There was need for extensive communication in the beginning. The reason for this was said to be the cultural differences in the buyer behavior of the customer:

"Keeping the schedule from our side is very important. Information is being shared more in [geographical location] than in [other geographical location] in the early phase of the project. Sometimes it is difficult because in the Finnish culture we tell things only when they are facts but here they do not wait that it is a fact. Rather the information needs to be approximated. The information flow needs to be fast." - Case company interviewee

On, the project workflow this showed two loops of communication cycle in the beginning with the engineering department where the concept of the plant was defined more.

The division of responsibility in the procurement was one of the main challenges in project A. This was noted also by observing one procurement meeting of project A where there were representatives from the case company, project partner and a consultant. The case company's procurement strategy as described by one interviewee:

"We try to source large systems and combine different purchase groups together if possible. For example, automation and electricity or valves from the same supplier or even the whole feed-in system." – Case company interviewee

The consultant was supposed to help with providing information of permitting and of two specific main components. However, the case company was expecting the consultant to also help in other procurement issues. Thus, sometimes the responsibilities of the project partner and consultant were not completely clear. In a later phase the project partner was also asked to help in the procurement of local components.

Uncertainty and late changes in the concept design affect the procurement. For example, the project partner did not want to discussions with suppliers of key components before the concept design was frozen. Project partner mentioned that a design change process needs to be put into use where the change idea will be given to the whole project team to evaluate risks and consequences. E.g. idea which brought value to the process adaptability and overall solution but might have caused problems in procurement:

"Changes after sending the first RFQ to an important supplier can reduce the "political power" of the customer. It gives implications that the customer does not know their business which could lead to higher bidding price and longer lead times." – Project partner interviewee

However, the concept design was changed still after a concept freeze after deciding whether it was feasible or not two to three times in project A. This did not happen in project B where the concept was frozen after the end-customer approved it in the memorandum of understanding (MOU). There was no clear process for accepting or approving change for the concept and basic design of the plant. Change requests were sometimes not clearly decided together with the project partners but instead decided by the case company and put straight into action. Therefore, in the procurement meeting a decision of handling the change requests together with the project team was done.

Basic design

Basic design was the main design and engineering task of the case company. Basic design task was necessary for both EPC and DBOT projects. Basic design would produce a description of the main components and pipelines needed for the plant. The process engineers need the customer requirement information and permitting needs. The basic design starts after the feasibility study has been approved. Below in Figure 13 we can see what happens when basic design task starts.

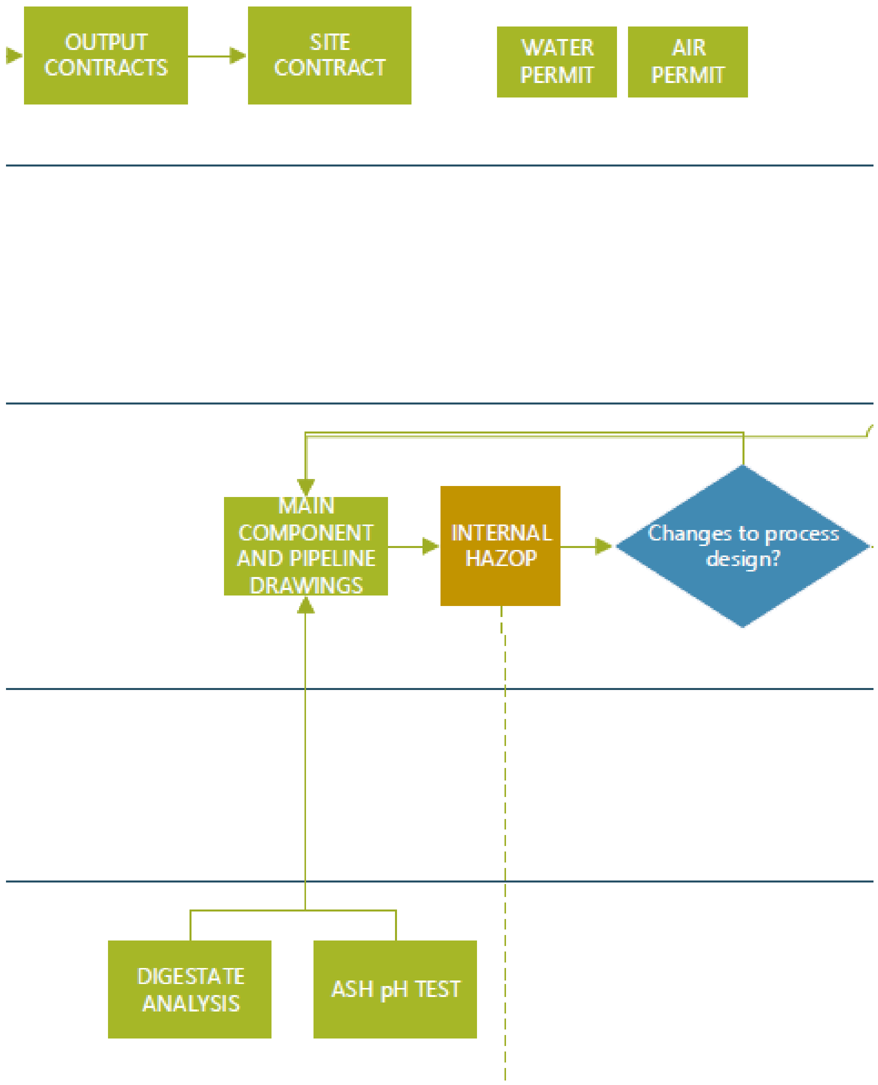

Figure 13. *Basic design, project A, version 1*

In the case of project A, several tasks affected the making of the main component and pipeline drawings which is the also the main deliverable of the basic design phase. The tasks which affected the basic design was testing information from the R&D laboratory, supplier 3D information for the combining the different main products together and feasibility reviews. Several feasibility reviews were done due to receival of additional information on the market prizes of the different main technology options.

Permitting was still quite unclear in both projects A and B. In project A there was a separate consultant who advised in permitting on the markets. In project B the permitting was handled by the end-customer of the project. An internal hazard and operability (HazOp) study was conducted in project A to make the plant safer and thus mitigate risks of needing to make drastic changes in the permitting phase of the project. The risks which were noticed in the HazOp study were then brought back to the first task of basic design which is the "main components and pipeline drawings".

Also, laboratory testing was done in the basic design process phase. The case company has their own R&D laboratory. The laboratory does tests on the input materials, process product quality and how different process innovations affect the production process. These tests can lead to several changes to the basic design of the plant. Some leading to major changes in choosing the main components and how to integrate them together. In project A the R&D conducted four main tests; first one for the main input material, second and third for the by-products and a fourth one for a new process innovation. On the other hand, in project B the only necessary test was for the input material.

After the basic design phase starts the detailed design which on this case was to be done by the project partner. However there were some challenges in the exchange of the design work for the project partner A;

"Then the idea is that the [cc] team hands off to the local, host country engineering team the job of doing country and site-specific engineering. On this case the hand-off did not happen soon enough." – Project partner A interviewee

The level of detail between basic and detailed design was perceived a bit differently between the case company and project partner A. According to the project partner A the engineering had gone to a more detailed level that was needed for their needs and it was too fixed already.

4.3 Interfirm collaboration in the projects

The main challenges lied in communication and the way of managing the projects. For example, it was not clear who were supposed to participate in the weekly project meetings and sometimes changes to the project were not clearly communicated to the whole project team. These challenges were brought up by both the case company's team members and from the project partners of project A.

"In [project A] we need to be communicating all the time since there are three different companies involved" - Case company interviewee

In several interviews the need for better ways of communicating inside the organization and between the project partners was emphasized. Remarks made for both sharing information through meetings or digital tools were mentioned. The project management style used in the project A was described as controlling rather than collaborative. Communication has developed between the partners in project A by first adding a new person to the project team by the project partner's side. Second, the partner firm was receiving a lot of questions on the progress which was probably due to lack of trust between the partners. However, this was fixed with increasing the conversation. Third, the issues shared in ad-hoc versus regular weekly meetings was changed. The weekly meetings focus was sometimes too focused on details. Therefore, after discussion the partners managed to elevate the discussion to focus on more general issues which is more beneficial to talk in the group. In the pre-project phase of the project B there were seen two types of meetings; project review meetings and project coordination meetings.

When asked about the main kind of conflicts or risks in this kind of collaboration the project partner A mentioned three of them; redundancy, competition and pricing pressures. Redundancy meaning that the company is in no need of certain services after learning enough of the market, competition of similar services in the market or if the company invests a lot to the partnership then the other company could negotiate the pricing of the projects. However, the project partner interviewee mentioned a fourth challenge which he described as being unique to this project A. The fourth challenge was described by the project partner A interviewee as *"there is an unforeseen gap in how the two entities combine to create all of the competences and all the capabilities that are needed to do a project correctly."*. This was related to the *"project leadership capabilities"* of both the case company and project partner A. This was an *"unforeseen gap"* in the project A.

The way the partners communicate between each other should reflect the role that the case company wants to take in the project network. According to an interviewee of the project partner "*[case company] needs to have a project manager, but that project manager needs to be presented to the other players like [project partner A] and [service provider] clearly as the actual role as [case company] wants it to be.*

4.4 The future state for case company's DBOT projects

On this chapter, the desired process framework for the case company's integrated solution delivery projects is presented. In the workshops made in the company the realized process models for project A and B were verified with the case company representatives. On the second day of the workshops each one who had been working for the projects were asked to specify their main tasks and to put them in the swim lane in the correct place. Then the whole process model was checked by the whole group. Also, milestones were added to divide the Design phase of the DBOT project model into four phases. The collaboration with the project partners happens throughout the whole process in weekly project meetings which are not described in the process model. However, the most important collaboration points and interfaces with the project partners are marked with stars in the process model. On these points the responsibility in the project changes for example from the project development to the engineering services unit and then after the basic design to the engineering partner who handles the detailed design of the solution.

There were conflicts in how the different phases were called. Some of the definitions used by the interviewees for the beginning of the DBOT project were project opportunity scoping, prospect phase or development opportunity. Since the activities in this phase are aiming for the beginning of project development phase we will call it project opportunity scoping. Below in Figure 14 the tasks of this phase can be seen.

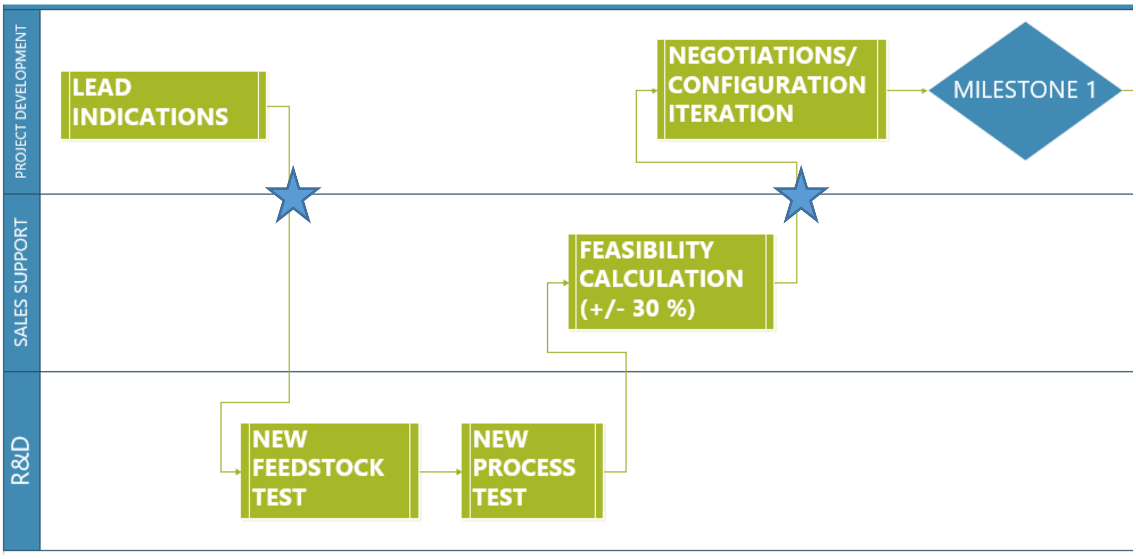

Figure 14. *Project opportunity scoping phase*

In Figure 14 the project opportunity scoping phase individuals responsible of project development gather indications of the lead. These include type and amount of input material and the optimal product types for the market. After this the R&D can do tests for the feedstock (input material) and possible process modifications needed for certain input materials and products. After this the sales support can do an estimation of the feasibility for the plant which support the negotiations made with the potential customer. The main difference made for the project opportunity scoping phase compared to project A and B was the R&D testing. Previously the feasibility calculations had been done with certain assumptions from the results of the company’s own pilot plant. However, in project A it was noted that it would be beneficial to at least test the input material in the very beginning to have precise numbers. Finally, when the business case for the project opportunity is viable and the necessary tests have confirmed the assumptions it will reach the first milestone and become a development project. In Figure 15 we can see the project development phase.

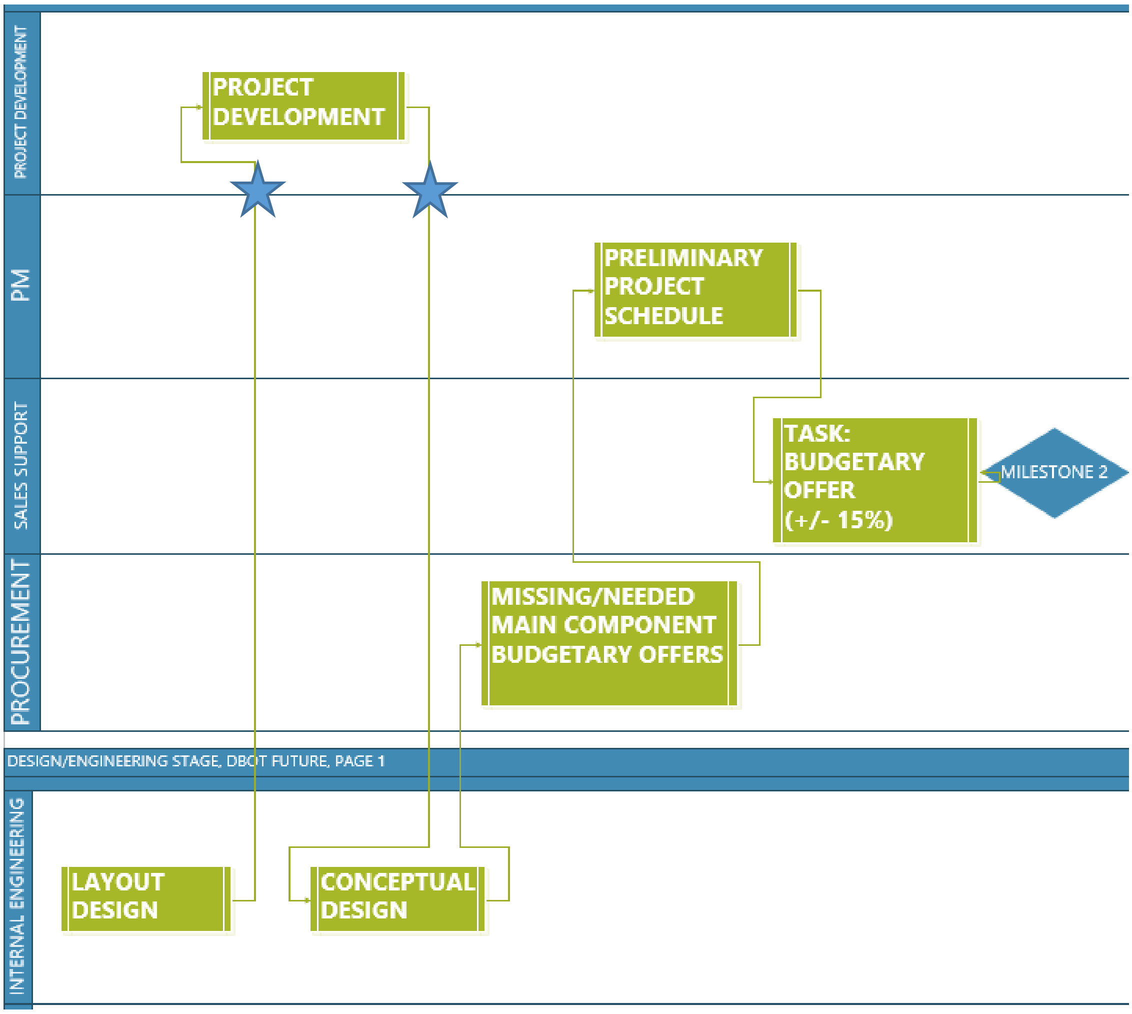

Figure 15. *Project development phase*

The project development phase starts with the design of the layout of the solution. After this the project development tasks continue with securing contracts of different input materials, product contracts and stakeholders' relations. The conceptual design starts after this phase, the project procurement starts with sending budgetary offers for missing main components, drafting the project schedule and refining the budgetary offer. Budgetary offer with necessary contractual agreements leads to the fulfillment of milestone 2 and towards the next phase.

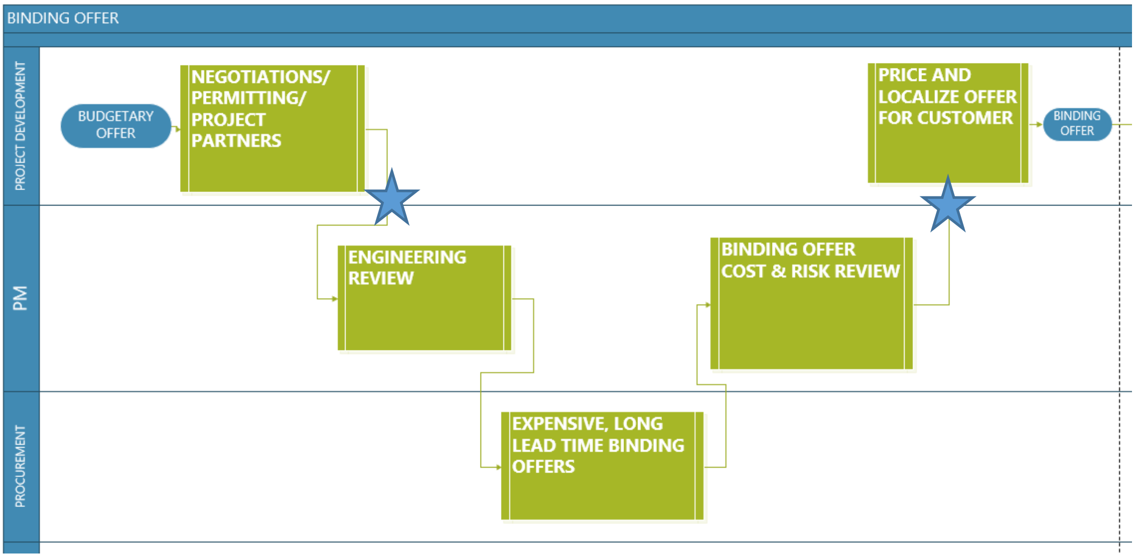

Figure 16. *Binding offer*

Sending and discussing about the budgetary offers starts the making of the binding offer for the customer. The project development unit is responsible of the negotiations, permitting and confirming the necessary project partners. After this, the project management takes care of arranging an engineering review which goes through the concept design made in the earlier phase. Procurement gather information of expensive and long lead time binding offers for the project management to finalize the binding offer through a cost and risk review. The project development unit then finalizes the offer for the customer. This ends the pre-project phase and starts the first phase of the execution phase which can be seen in the Figure 17 below.

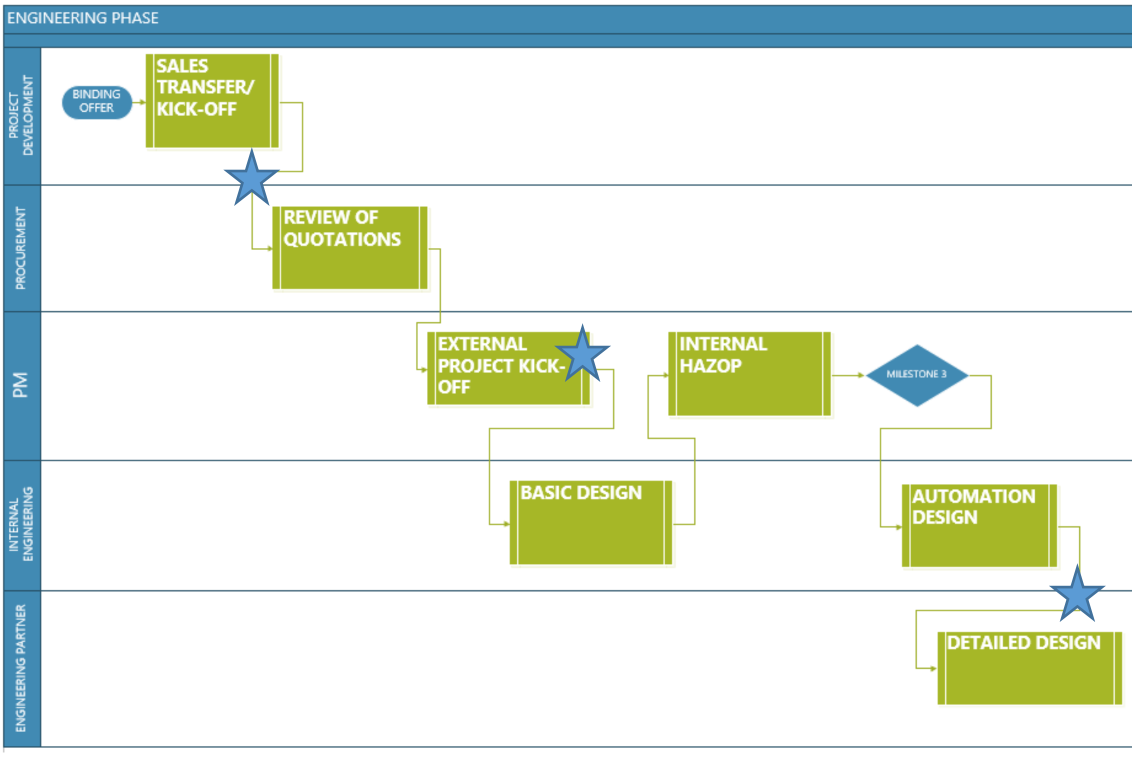

Figure 17. *Engineering phase*

The engineering phase starts the project with a transfer from sales in the project kick-off meeting. The procurement continues to review the quotations received and the project manager organizes an external project-kick off with the project partners. The internal engineering department starts the main component and pipeline drawings in the basic design task which then is reviewed together in an internal HazOp meeting. After this the milestone 3 of the project has been achieved by making sure the design is frozen, the binding contract has been signed and project partner contracts have been signed. This starts the detailed engineering which includes automation tasks done internally and detailed design which is usually outsourced to a local, engineering partner.

5. DISCUSSION

5.1 Requirements to deliver integrated solutions

5.1.1 Solution-orientation

One of the most important requirements to deliver integrated solutions is to be solution-oriented rather than product- or service-oriented. (Brady et al., 2005) There were different views about the goals of the projects between the different roles in the company. The project manager and head of engineering saw the project as to what was to be delivered. On, the other hand the process engineers saw the projects through the services provided. Therefore, they considered the projects A and B were similar since the provided core technology is the same and tasks such as basic engineering and detailed engineering are needed. The sales managers of the company however, understood the difference between the two different projects through the different types of customers and value propositions they had. Another aspect of how the solution-orientation worked in the company was the amount of changes made to the design. Some were perceived as negative for the project although from a solution-oriented perspective each change is good if the benefit for the overall solution and to the customer is positive.

Information about the customer segment and their value propositions was not clear with all the members of the project team. Customer point of contact was mainly the sales/developer personnel which could be outsourced. Therefore, the inner organization did not have a clear picture of the customer which was served and their primary needs and value proposition. In both projects the revenue model was the same, but the extent of the delivery project was different. For example, in project A the company provided the financing for the project and procured business consultation from the project partner as a service.

5.1.2 Capabilities

According to Brady et al. (2005) there are four main capabilities to deliver integrated solutions. These are financial, systems integration, business consulting and operational service capabilities. Below in Figures 18 and 19 we can see how the core capabilities of integrated solutions deliveries have been divided between the project network in project A and project B.

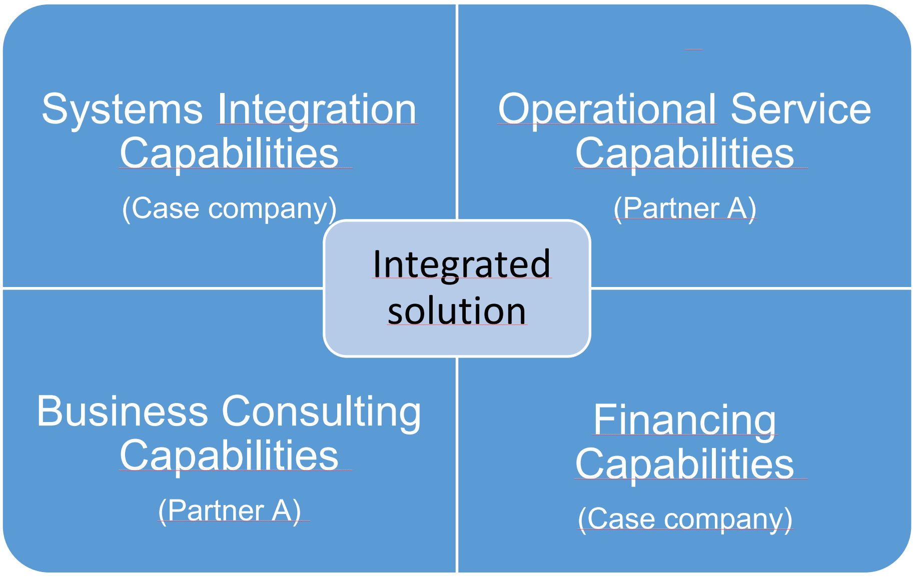

Figure 18. *Integrated solution capabilities in Project A*

In the project A the case company has the responsibility of integrating the whole system together and taking care of the financing of the project. Project partner A on the other hand will be granted the operation and maintenance (O&M) contract and they have been consulting the case company about the new markets. Also, they have been taking part in the pre-project part where the project has been developed. This has included working with the local stakeholders. An external consultant has also been consulting about specific subjects such as permitting and sourcing of some systems. The core capabilities of delivering an integrated solution have therefore been divided equally between the case company and project partner A. In Figure 19 below we can see how the capabilities were divided in project B.

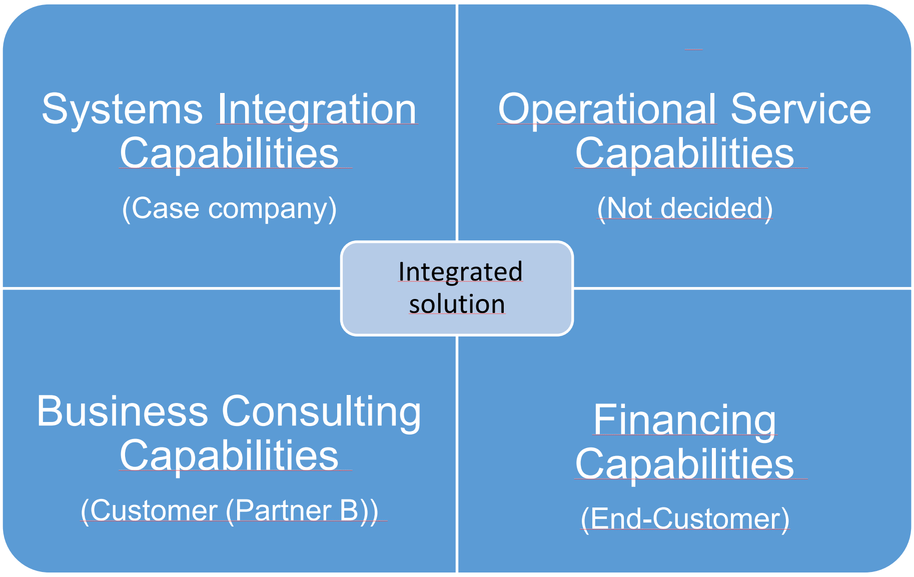

Figure 19. *Integrated solution capabilities in project B*

When compared to project B the case company is only taking care of the integration of their own technology to a larger system. Therefore, some systems integration capabilities are also needed. However, the end-customer is taking care of the financing and the partner B is doing some consulting for the end-customer of the different technologies which are available for their use such as the case company's technology.

Business consultation capabilities

The company was not familiar with the market beforehand in both projects. Therefore, partnerships were established in each new geographical market to consult the case company for example of legislative procedures, product prizes and the market sizes. All the customer requirement information was not available in the beginning of the project A where value proposition was formed. In project B the end-customer and the case company's direct customer were included from the beginning. The end-customer supported the project B in hiring their own team to help with clarifying the specifications and with permitting issues. In project A the lack of market information and customer input were one of the causes which led to several iterations in the design phase causing re-work for the process engineers.

Systems integration

Systems engineering requires knowledge of different systems and how they work together to successfully integrate them together (Hobday et al. 2005). While interviewing the process engineers they lifted this concern up saying that the company would need more information from the sourcing consultant about the different options in the market. For example, the 3D information of systems is important while designing the layout and needed site size for the solution. Having the power to design the whole system has however brought several benefits and the company has made several process innovations in the process of designing the power plant.

The role of the company's R&D laboratory was discussed in the interview with the head of R&D and in the workshops. It was noted that for example in project A some of the testing was done during and after basic design activities which caused problems and re-work for engineering. The results of the prototyping can lead to changes for the whole concept or to individual technologies which are integrated. This supports the research of Shenhar (1998) where he arguments that when the uncertainty of the technology increases the project should be granted more flexibility to prototype and test different solutions. Also, on this case study it was noted that the prototyping should be done in the beginning of the process to support the estimates for the value proposition. Therefore, on the future state model which can be seen in Appendix D the testing of input and system prototyping were moved to be done as one of the first steps in an integrated solution project.

Procurement tasks were moved to the project partner A. These were components and products which are reasonable to source locally which could be better for example for the service and operating of the plant. Also, the partner has the detailed knowledge of the plant and therefore can accumulate knowledge on spare parts and locally sourced parts. The procurement strategy of the company is aligned with a system integrator. System integrator focuses on integrating different systems together. The system integrator can choose to outsource the detailed engineering and the manufacturing of components and systems to suppliers. (Davies, 2004) However, the case company is taking a bigger risk in first building the project A and then selling it to an interested investor the procurement has not been able to start yet.

Financing capabilities

In the project A the company has been handling the financing for the development and construction period themselves. Therefore, for example the developers of the project have been talking a lot about de-risking the project and how the financial risk behind the project has led to the case company into taking a more controlling collaboration method in working with the project partners. Notions of how the case company perceives higher risks were made during the workshops about the integrated solution delivery.

Operational service capabilities

The case company will not operate and maintain the plants which are produced in the project A and B. Therefore, the project partner A will be granted the O&M (Operation and Maintenance) contract for that plant. The company is still looking for a potential partner to operate the plant of project B.

5.1.3 Supporting infrastructure

Storbacka (2011) mentions ICT tools as one of the most important supporting infrastructures to deliver integrated solutions. However, the process engineers saw no additional value in ICT systems which support co-engineering with the project partner's engineers. This was due to risk of modifications causing changes to several parts of the system. The design is done by integrating together interrelated sub-systems. The challenge lies in systems integration where there are many interrelated systems which need to be considered. Basic design diagrams may be modified, after which the modifications must be transferred to the 3D model of the plant. However, ICT tools would be beneficial in increasing the communication and thus collaboration between system suppliers and project partners.

The design engineers need information from the sales and sourcing systems to do design decisions in the system engineering phase. However, the company is investing heavily on building the whole ICT infrastructure which would be fully integrated so that the information of the project will flow through each phase smoothly. This can be seen also in list of information system list of requirements listed in Appendix C. There are two functionalities which would support the project partner co-operation from the point of view of engineering and project management. A co-operation workspace is planned to be used to facilitate the communication between the project partners.

5.2 The process of delivering integrated solution projects

5.2.1 General process flow

In the project A there are no clear decision points or milestones as seen in the Appendixes E and F. Therefore, the project develops uncontrollably and has been causing problems in forms of rework for the process engineers and delays in procurement. In Figure 20 below there is a depiction of the general process flow.

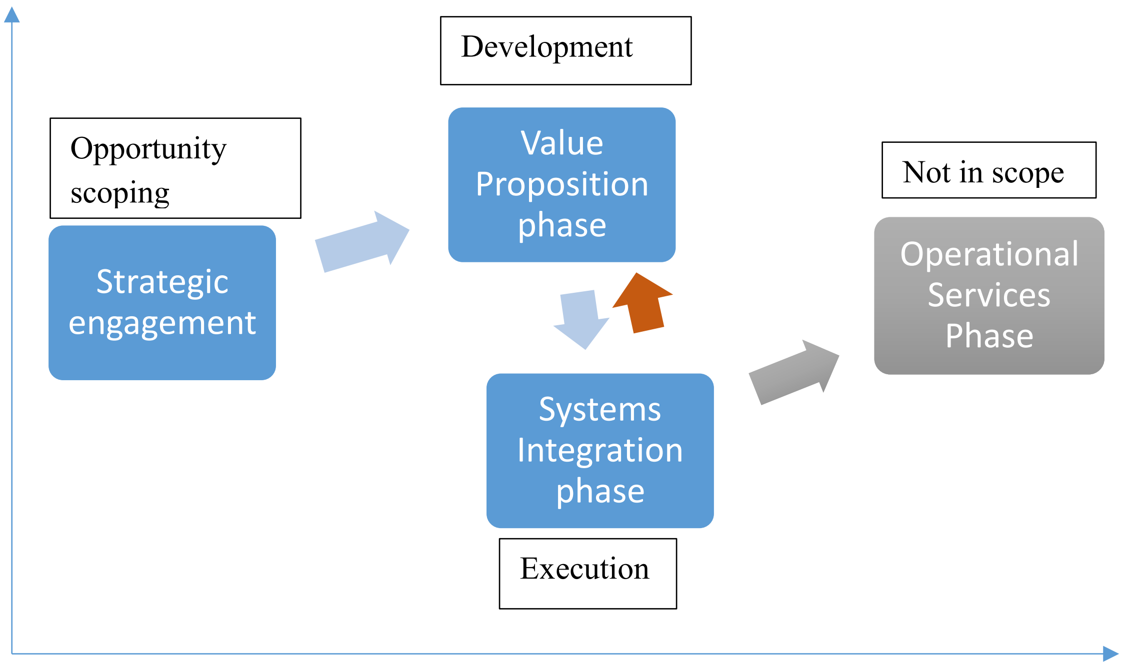

Figure 20. Integrated solution life cycle phases (According to Brady et al. 2005)

As we can see in the Figure 20 above the integrated solution life cycle in the project A had some difficulties due to the concurrence of the value proposition and the systems integration phases. This led to several iterations in the technical design of the solution and an excessive amount of rework. The head of engineering estimated the amount of design cycles to be 9 times more in an integrated solution delivery versus the project B which is EPC delivery where the specifications of the system were clear from the beginning. In the workshops remarks were made of the project A as being a sort of an R&D project where the company is optimizing the solution to the market and thus ending up doing concurrent engineering at the same time as integrating the systems together and updating the value proposition of the solution. The company wants to introduce its product to the market as soon as possible which can also be one of the reasons which have led to concurrent phase execution.

The process model was updated to clarify the different phases of the project. These were presented in the results in Figures 14 (Project opportunity scoping), 15 (Project development phase), 16 (Binding offer phase) and 17 (Engineering phase). The project opportunity scoping reflects the strategic engagement phase. The project development and binding offer phase is related to building the value proposition for the customer. The engineering phase starts the systems integration tasks. Next these different phases are analyzed.

5.2.2 Strategic engagement and value proposition phase

According to the CMO of the company main differences for the company in the between the two types of project deliveries is the extended pre-project phase with additional tasks for the integrated solution project.

The head of one of the regional units concluded that they have many possibilities to develop DBOT -projects to the specific market but that he sees the product deliveries as more beneficial for the company as they do not require investing so much financial resources into them. The value proposition phase of the project B has been quite straightforward. Need for extensive communication in the beginning. The reason for this was said to be the cultural differences in the buyer behavior of the customer. On the project workflow this showed two loops of communication cycle in the beginning with the engineering department where the concept of the plant was defined more. Another difference in the project B was that after checking if the preliminary design was feasible the customer makes the decision whether they want to continue.

5.2.3 Systems integration phase

Several design iterations took place during the basic design phase of the project A as mentioned in the results. This may be natural for the first project and especially in high-technology projects or due to trying to “fast-track” product development. (Levitt et al., 1999) who studied how companies are trying to “fast-track” the product development which can lead to several managerial challenges. These relate to task interdependence and the coordination of the project team work. Also, the degree of technological uncertainty can lead to need for more iterations and a more flexible managerial style for the pace of the project and emphasis on communication, as noted by Shenhar et al. (2002).

In the workshop remarks were made of the project A as being *“a sort of an R&D project where the company is optimizing the solution to the different markets”.* This has led to several changes in the design while integrating the systems together and updating the value proposition of the solution. Geraldi et al. (2009) presented a systemized change request process as one way of avoiding the chaos of changes in complex projects. This was a necessary change which was also noted in the project A by the project partner. Project partner mentioned that a design change process needs to be put into use where the change idea will be given to the whole project team to evaluate risks and consequences. E.g. an idea might bring enhance the process adaptability and the overall solution but might have cause problems in supplier relationships.

5.2.4 Interfirm collaboration

One of the clear benefits of the collaboration between the partners was the possibility to acquire additional capabilities. This was also brought up by both Du et al. (2016) and Davies et al. (2006) when they studied benefits of interfirm collaboration for large PBFs. Other benefits were also realized. In project A the company entered new markets with the help of project partner A which was mentioned as one of the benefits for SMEs in manufacturing networks by BarNir & Smith (2002). Additionally, the project B was a subsequent project with the customer who could also be considered as a project partner (Tikkanen et al. 2007).

Additional tasks were moved to the partner considering the procurement of goods which are reasonable to source locally. Better for example for the service and operating of the plant. Also, the partner has the detailed knowledge of the plant and therefore can accumulate knowledge on spare parts and locally sourced parts. The system integrator will therefore focus on the core technologies (Kujala et al. 2013) for the plants. This way the company which handles the core products also handle the maintenance of those. And on the other hand, the partner company handles with the facilitating products and services.

As mentioned in the study of Martinsuo (2011) supplier integration requires more of a collaborative way of working with the partner who is in this case a service provider for the project. The way the partners communicate between each other should reflect the role that the case company wants to take in the project network.

According to Davies et al. (2006) large companies such as Cable & Wireless, Atkins and Ericsson choose different strategies in developing capabilities to expand their offerings to solutions. Like Cable & Wireless which offers consultancy through their partnership with one of the biggest consulting companies, Accenture. Others such as Atkins and Ericsson have developed their own consultancy organizations. The case company was entering new markets as an SME. Therefore, the company did not have the necessary market knowledge to “develop” the projects alone. Therefore, the project partner A has been doing the business development work and thus consulting the case company. However, it has been planned that the development work might be done by the case company’s sales unit in the future which might mean the realization of the redundancy risk which the project partner A interviewee mentioned. Therefore, project partner needs to also expand their capabilities to serve the case company better. This can be done through analyzing the partners capabilities and agreeing on which capabilities the other should concentrate on.

5.3 Recommendations for the case company

The project company is aiming to scale up their international project business rapidly in the following years. Recommendations which would support systems integration and interfirm collaboration between project partner are presented next in prioritized order.

Internal project communication practices

Information about the state of the project portfolio should be clearer for everyone working for different projects to plan better the resource needs for different time periods. Therefore, I suggest a monthly check-up for the whole company of the state of the portfolio. These meetings would also serve in exchanging valuable information about the different customer segments in the different geographical markets which would help the engineering services unit to understand the customer needs better and to plan their work in the following weeks according to prioritization.

Collaborative leadership

The company is dependent of their project partners which bring in the needed capabilities for the project deliveries. Thus, a partner is different than a supplier of components and the co-operation should be managed in a different manner. Between the project partners there could be nominated a collaborative leader who would take care of the collaboration between the partners. This way, the needs of both would be considered and the project would be led in a more collaborative than controlling way.

Including the R&D function in the early stage of DBOT projects

The R&D laboratory was a separate support function which was not present in the project A meetings. However, R&D plays an important part in testing the different solutions which are planned for the customer. This is especially the case in DBOT projects where the size of the project is usually bigger and the integration of the company’s own technology with the overall system must be tested.

6. CONCLUSIONS

6.1 Achievements of the study

This study resulted in the creation of new understanding of the processes and requirements for an SME to deliver integrated solutions by collaborating with other companies. The four main capabilities (financing, systems integration, operational services, business consultation) for delivering integrated solutions were spread between the project partners in project A. The complementary capabilities, entering new markets and acquiring subsequent projects were the main benefits of interfirm collaboration. The complementary capabilities were the primary reason for the partners to choose to collaborate between each other. In integrated solution deliveries the pre-project phase is extended as found out in the case project A, thus a clearer clarification of the milestones between the four integrated solution delivery phases was confirmed to be necessary in the case study. A systemized change request process was needed in the design phase of the solution. Especially important when there are two different and remote organizations collaborating in the design work of the solution. Iterative design process between the partners was not wished for. More supporting infrastructure in form of ICT tools was wished to enhance project collaboration between suppliers and projects rather as a communicative tool than as a collaborative design tool. Challenges in the interfirm collaboration process were mainly due to lapses in communication and the lack of a collaborative management style.

In the project management literature there has been a lack of operation management studies. Therefore, the construct done in this study is aimed to offer one type of a process model to project where the project complexity is mainly due to technological uncertainty and socio-political issues.

6.2 Limitations

The projects in hand are the first ones on their target markets for the company. Therefore, some challenges can be due to the nature of a first reference project in the markets. The projects A and B were delivered to different kinds of customers, in different geographical markets which encompass a different set of regulations and stakeholders. This affects the validity in doing a cross-case comparison between such different kinds of projects.

Also, the company is small and therefore the members of the team had very different views and knowledge related to their field of expertise such as automation, process engineering or project management. Therefore, it was not possible to compare for example answers on how two different automation engineers would do the same tasks but some of the findings might be biased due to the way one member does a certain task. The construct and research findings were validated in the workshop and in a separate meeting with the company's Chief of Operations (COO).

6.3 Further research topics

The operations management body of literature is lacking in studying the processes of delivery projects. (Geraldi, Maylor, & Williams, 2011; Geraldi, 2009). Additionally, research of integrated solution delivery projects has been mainly in large companies with vast resources. (Davies et al. 2004). Therefore, further studying of how SMEs can deliver these kinds of complex products and systems is important. On this study the case company chose to partner up with potential clients or service providers when going to a certain market. The study could be extended with more case studies of SMEs providing integrated solution delivery projects. Also, this study focused on studying the pre-project and design phase of the DBOT project thus a longitudinal study of the whole lifecycle would be beneficial in order to observe how the interfirm collaboration evolves between the project partners. A third area of further research could be of the possible risks of collaborating with a project partner (redundancy, competition and pricing pressures). Finally, the empirical study identified that a perceived financial risk can lead to more changes in the design phase of the solution. However, this should be validated further with a bigger sample size of IS projects. This way, especially SMEs could have more recommendations on how much risk to take in their first projects.

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APPENDIX A: INTERVIEW FRAME

Background information:

1. Name of the interviewee
2. Role in the company
3. Main responsibilities in the projects
4. How is your own workflow in the project? Imagine that you would need to brief me into fulfilling the tasks

Interview:

1. Could you describe me in general the Project A and B?

PROJECT SPECIFIC (2 ROUNDS, PROJECT A AND PROJECT B)

2. What is the duration of the project?
3. How was the project given to the company? Specifications and information from the customer?

TECHNICAL

4. What is the project scope and end-product to be delivered to the customer?

PROCESS

5. Into what kind of parts can the project be divided?

ORGANIZATIONAL

6. How does the communication flow look like between engineering and procurement?

PROCESS

7. What are the critical tasks of the project?

ENVIRONMENTAL

8. What kind of stakeholders are included in the project?
   a) Their roles?
   b) On which points are they included in the project?

PROCESS

9. What kind of milestones are there in the projects? E.g. Need to go through the project with investors and customers?
10. What kind of activities have been already done?
11. What is going to come next?
12. What information is needed for the next steps?

COMPARISON:

13. How do the company’s projects differ from each other? Project A and B?
14. What kind of similarities do they possess

APPENDIX B: PROJECT A, PLANNED TASKS

1 **Milestones 280 days Tue 9.1.18 Mon 4.2.19**
2 **Project Kick-off 0 days Tue 9.1.18 Tue 9.1.18**
3 **Conceptual Design completed 0 days Thu 15.2.18 Thu 15.2.18 11**
4 **Basic engineering completed 0 days Fri 31.8.18 Fri 31.8.18 31**
5 **Detail Engineering Completed 0 days Thu 15.11.18 Thu 15.11.18 54**
6 **2T operating permit filed 0 days Thu 1.11.18 Thu 1.11.18 70**
7 **Water permit received 0 days Fri 19.10.18 Fri 19.10.18 69**
8 **Post Commissioning Purchase Agreement in place 0 days Wed 24.10.18 Wed 24.10.1893**
9 **Fertilizer Agreements identified 0 days Wed 31.1.18 Wed 31.1.18 97SS+86 days**
10 **Financial close, NTP 0 days Mon 4.2.19 Mon 4.2.19 11;31;54;68**
11 **Conceptual Design 28 days Tue 9.1.18 Thu 15.2.18**

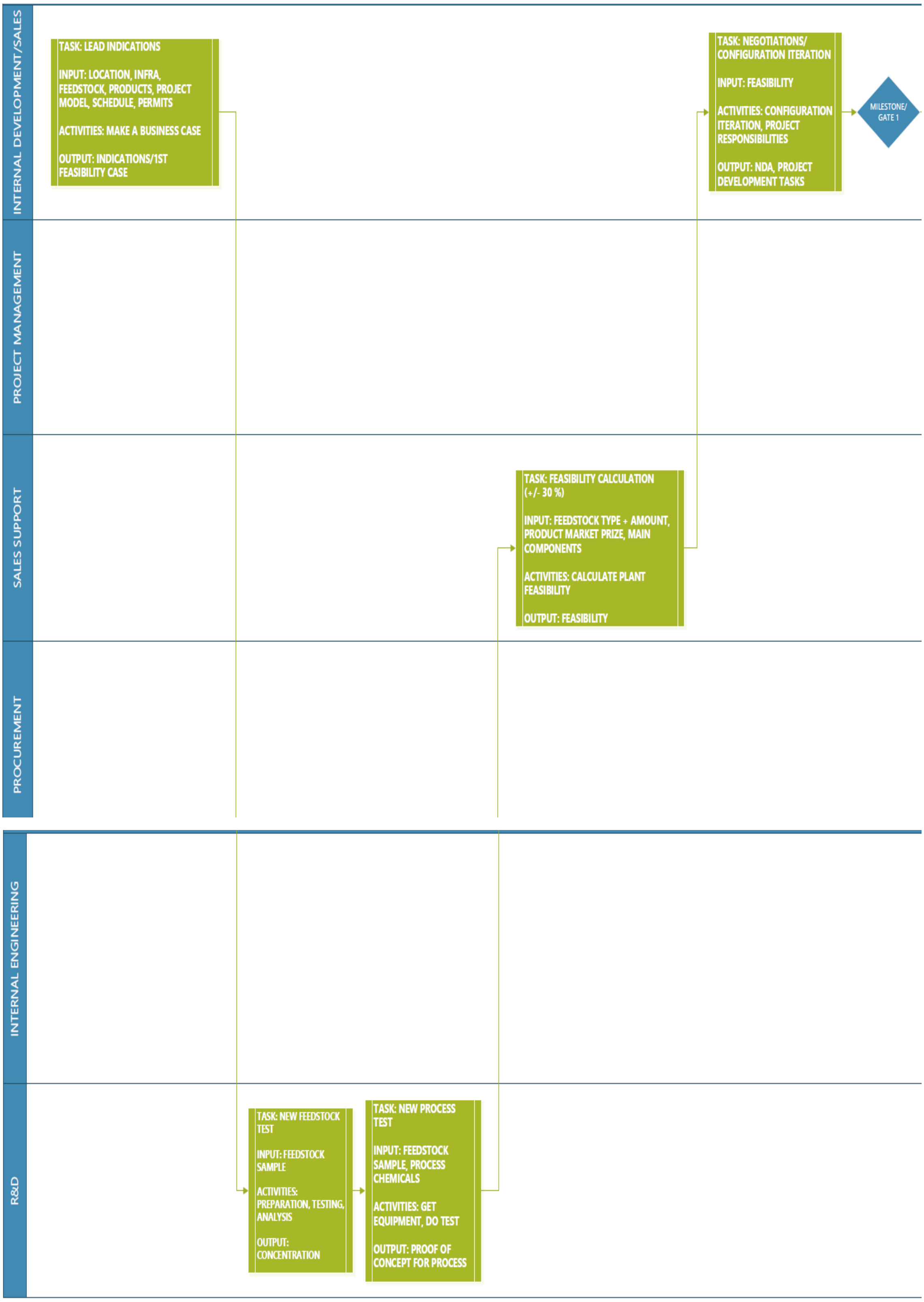
12 Basis of Design, Short description	13 Project Objective, Short description	14 Time Schedule, Level 2
15 CAPEX, 25 - 30 %	16 Block Diagram	17 PI Diagrams, preliminary
18 Main equipment list, preliminary	19 Area lay-out, Preliminary	20 Utility balance, preliminary
21 Mass balance, preliminary	22 Permission documentation requirements, list	23 List of chemicals, Final
24 Process safety, Safety permitting Requirements	25 Area classification, preliminary	26 Equipment detail lists, preliminary
27 Instrumentation lists, preliminary	28 Automation, preliminary	29 Load list - Electrical, preliminary
30 Emission & Waste, preliminary	31 **Basic Engineering 169 days Tue 9.1.18 Fri 31.8.18**	32 Basis of Design, AFD level
33 Project Objective, Detailed	34 Time Schedule, Level 3	35 CAPEX, 10 - 15 % 21 days
36 Flow diagrams, AFD level	37 PI Diagrams, AFD level	38 Main equipment list, Final
39 Area lay-out, AFD level	40 Utility balance, AFD level	41 Mass balance, AFD level
42 Permission documentation requirements, Final	43 Process safety, HAZOP Step 1	44 Area classification, AFD level
45 Equipment detail lists, AFD level	46 Instrumentation lists, AFD level	47 Automation, AFD level
48 Load list - Electrical, AFD level	49 Emission & Waste, Final	50 Geotechnical Survey, Final
51 Equipment load map, Preliminary	52 Basic Civil engineering, AFD level	53 Project execution plan, Final
54 **Detail Engineering**	55 Detail engineering kick-off	56 Civil engineering
57 Hydraulic load drawings for permitting	58 Equipment load map	59 Project execution plan, preliminary
60 Sourcing strategy	61 Mechanical and piping design	62 Process safety, HazOp Step 2
63 Equipment detailed drawings	64 Electrical engineering	65 Instrumentation engineering
66 Automation engineering	67 Automation system	68 **Permitting**
69 Water permit registration	70 Studies for operating permit	71 Operating permit
72 Minor / Local permits	73 Construction RFP	74 **Agreements**
75 Interconnect	81 [Input material]	87 **Transactional**
88 [Project Partner] Services Agreement	89 [Partner A] O&M Agreement	90 [Project Partner A] Development Agreement
91 [Project Partner] Services Agreement	92 Litter Consultant Agreements	93 Post Commissioning Purchase Agreement
94 Offtake	101 **Procurement**	102 Overall Sourcing strategy, preliminary
103 Vendor lists	104 Budgetary quotations	105 Final Binding Commercial quotations
106 Procurement of Civil works (LLC scope !!)	107 Procurement of long lead equipment	108 Procurement of rest of the equipment
109 Procurement of the installation and erection works	110 **Equipment delivery**	111 Delivery of the Boiler
112 Delivery of the Gas upgrade	113 Delivery of short lead equipment	114 **Site Works**
115 Boiler installation (EPC)	116 Gas Upgrade Installation (EPC)	117 **Gas upgrade ready**
118 Civil works	119 Main equipment erection and installation	120 Auxiliary equipment installation
121 Steel structures and piping erection works	122 Operator training	123 Electrification works
124 Instrumentation and automation works	125 Equipment Insulation works	126 Piping insulation works
127 **Mechanical completion**	130 Commissioning and water runs	133 Start-up
134 **Hand-over**		

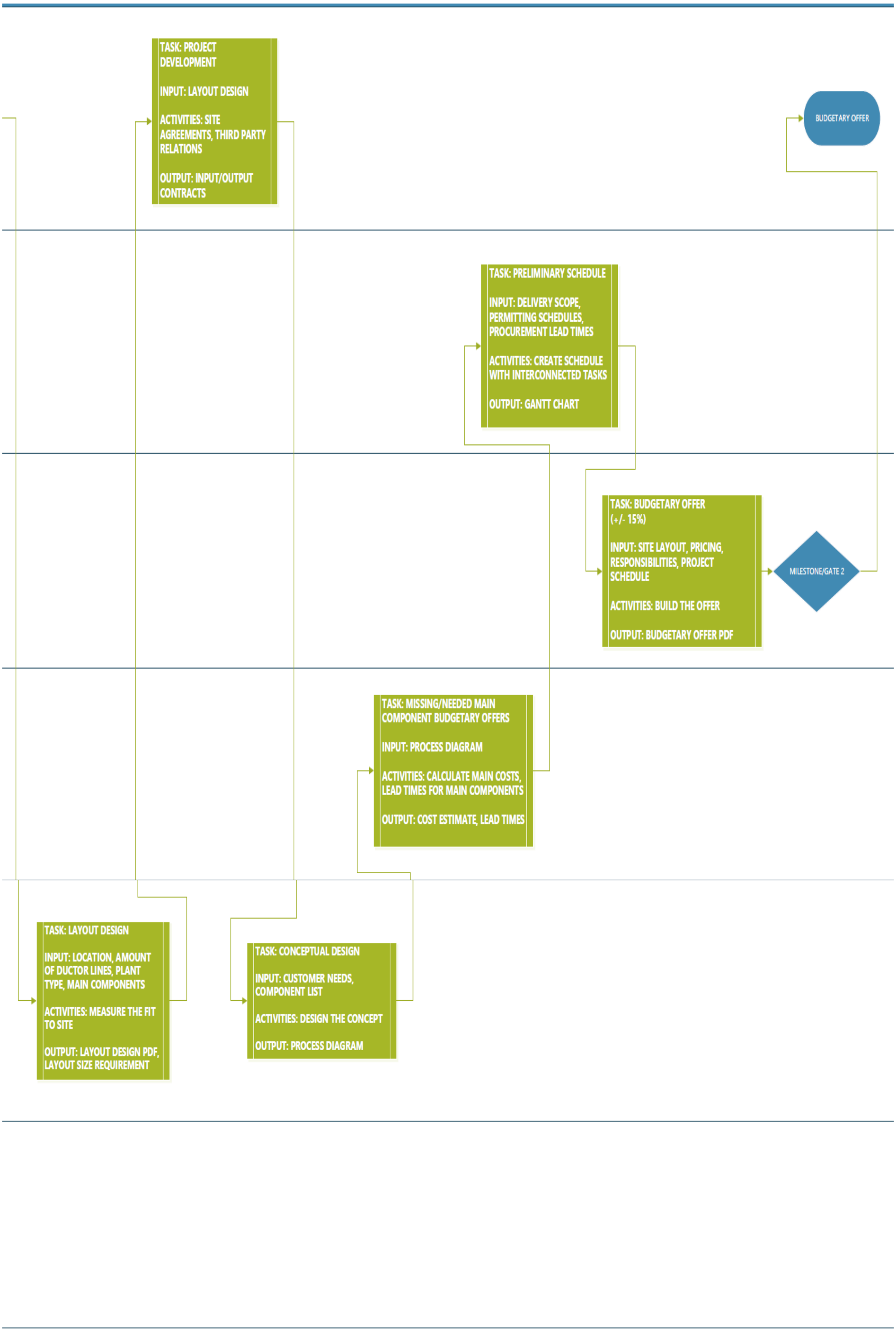
APPENDIX C: INFORMATION SYSTEM FUNCTIONALITY, SECONDARY MATERIAL

L1 process	L2 Process		Activity	User role
1. Sales	1.1 Customer Management	1	Customer Data Collection	Marketing
1. Sales	1.1 Customer Management	2	Customer Data Management	Sales / Marketing
1. Sales	1.1 Customer Management	3	Customer activity logging	Sales
1. Sales	1.1 Customer Management	4	Customer analytics	Sales
1. Sales	1.2 Prospect Management	1	Initial BC/ROI Calculation	Sales
1. Sales	1.2 Prospect Management	2	Input data collection and R&D concept validation	Sales
1. Sales	1.2 Prospect Management	3	Basic Configuration and Conceptual Offer	Sales
1. Sales	1.3 Offer Development	1	Resource need forecast	??
1. Sales	1.3 Offer Development	2	Budgetary offer	Sales
1. Sales	1.3 Offer Development	3	Binding offer	Sales
1. Sales	1.4 Sales Engineering	1	Template configuration development	Engineering
1. Sales	1.4 Sales Engineering	2	Offer specific configuration based on template	Engineering
2. Delivery	2.1 Engineering	1	Transfer of configuration from Sales to Delivery (PLM to ERP)	Engineering
2. Delivery	2.1 Engineering	2	Detailed Engineering	Engineering
2. Delivery	2.1 Engineering	3	Partner co-operation	Engineering
2. Delivery	2.1 Engineering	4	Documentation approvals	Engineering
2. Delivery	2.2 Supplier Management	1	Supplier data management	Procurement
2. Delivery	2.2 Supplier Management	2	Supplier price list management	Procurement

L1 process	L2 Process		Activity	User role
2. Delivery	2.3 Procurement	1	Opening RFQs to selected suppliers	Procurement
2. Delivery	2.3 Procurement	2	e-bid capability	Procurement
2. Delivery	2.3 Procurement	3	Issue PO	Procurement
2. Delivery	2.3 Procurement	4	Order confirmations	Procurement
2. Delivery	2.4 Project setup	1	Project setup from quotation / sales case	Project Management
2. Delivery	2.4 Project setup	2	Partner co-operation workspace setup	Project Management
2. Delivery	2.5 Project Management	1	Status updating	Project Management
2. Delivery	2.5 Project Management	2	Resource management	Project Management
2. Delivery	2.5 Project Management	3	Change Management	Project Management
2. Delivery	2.5 Project Management	4	Cost and Schedule update	Project Management
2. Delivery	2.5 Project Management	5	Reporting	Project Management
2. Delivery	2.5 Project Management	6	Status Reporting	Project Management
2. Delivery	2.6 Site Logistics	1	Receival of goods	Project Management
2. Delivery	2.6 Site Logistics	2	Claim management	Project Management
3. Finance	3.1 Capital management	1	Cash flow forecasting	Finance Management
3. Finance	3.1 Capital management	2	Finance need forecasting	Finance Management
3. Finance	3.2 General Accounting	1	Local accounting / GL	Finance Management
3. Finance	3.2 General Accounting	2	Corporate accounting	Finance Management
3. Finance	3.3 Payments and Receivables	1	Payment approvals	Finance Management
3. Finance	3.3 Payments and Receivables	2	Collection	Finance Management
3. Finance	3.4 Salaries and expense mgt	1	Salary managemnt	Finance Management
3. Finance	3.4 Salaries and expense mgt	2	Expense management	Finance Management

APPENDIX D: FUTURE STATE PROCESS MODEL, INTAGRATED SOLUTION




TASK: PROJECT DEVELOPMENT

INPUT: LAYOUT DESIGN

ACTIVITIES: SITE AGREEMENTS, THIRD PARTY RELATIONS

OUTPUT: INPUT/OUTPUT CONTRACTS
BUDGETARY OFFER
TASK: PRELIMINARY SCHEDULE

INPUT: DELIVERY SCOPE, PERMITTING SCHEDULES, PROCUREMENT LEAD TIMES

ACTIVITIES: CREATE SCHEDULE WITH INTERCONNECTED TASKS

OUTPUT: GANTT CHART
TASK: BUDGETARY OFFER (+/- 15%)

INPUT: SITE LAYOUT, PRICING, RESPONSIBILITIES, PROJECT SCHEDULE

ACTIVITIES: BUILD THE OFFER

OUTPUT: BUDGETARY OFFER PDF
MILESTONE/GATE 2
TASK: MISSING/NEEDED MAIN COMPONENT BUDGETARY OFFERS

INPUT: PROCESS DIAGRAM

ACTIVITIES: CALCULATE MAIN COSTS, LEAD TIMES FOR MAIN COMPONENTS

OUTPUT: COST ESTIMATE, LEAD TIMES
TASK: LAYOUT DESIGN

INPUT: LOCATION, AMOUNT OF DUCTOR LINES, PLANT TYPE, MAIN COMPONENTS

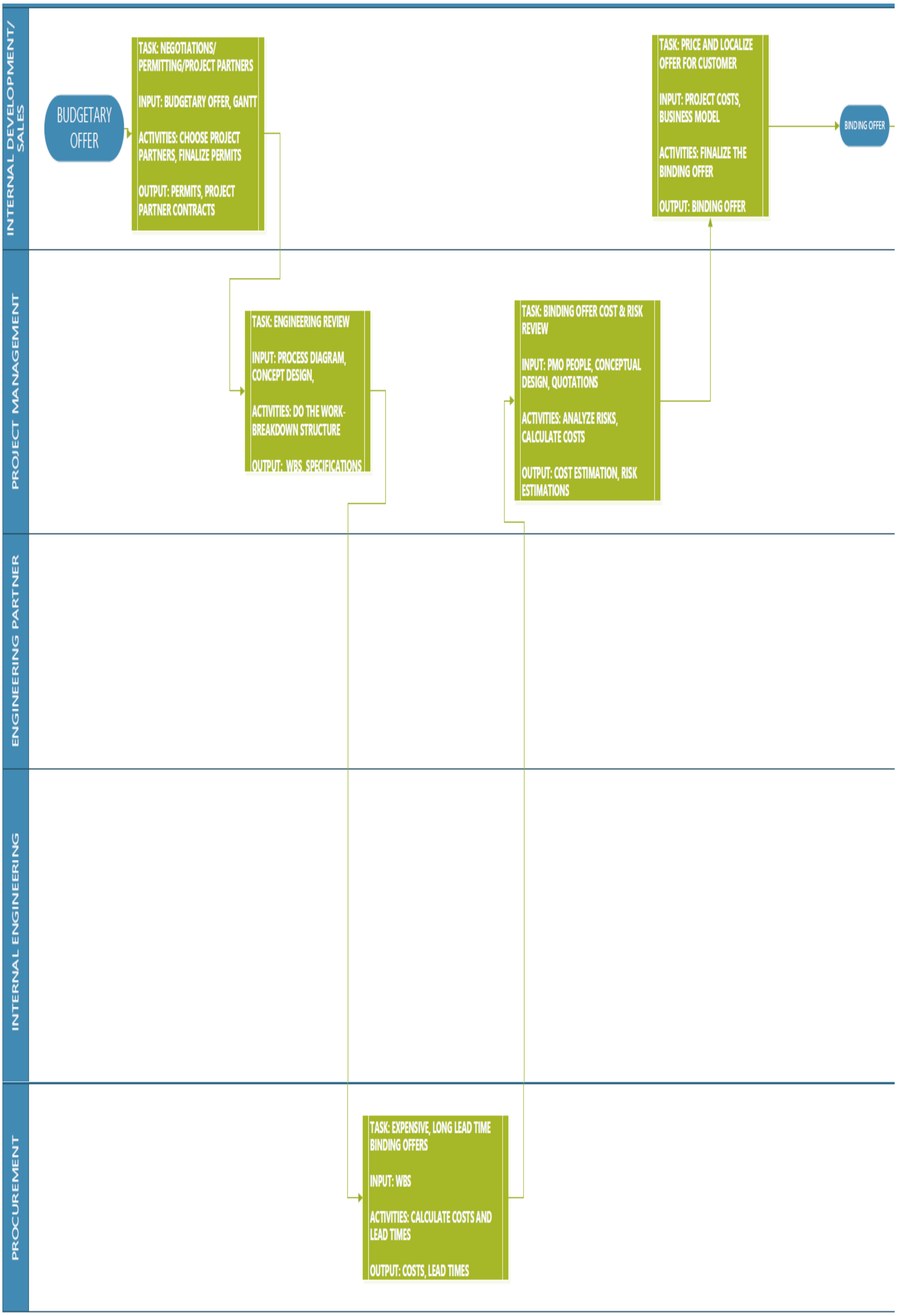
ACTIVITIES: MEASURE THE FIT TO SITE

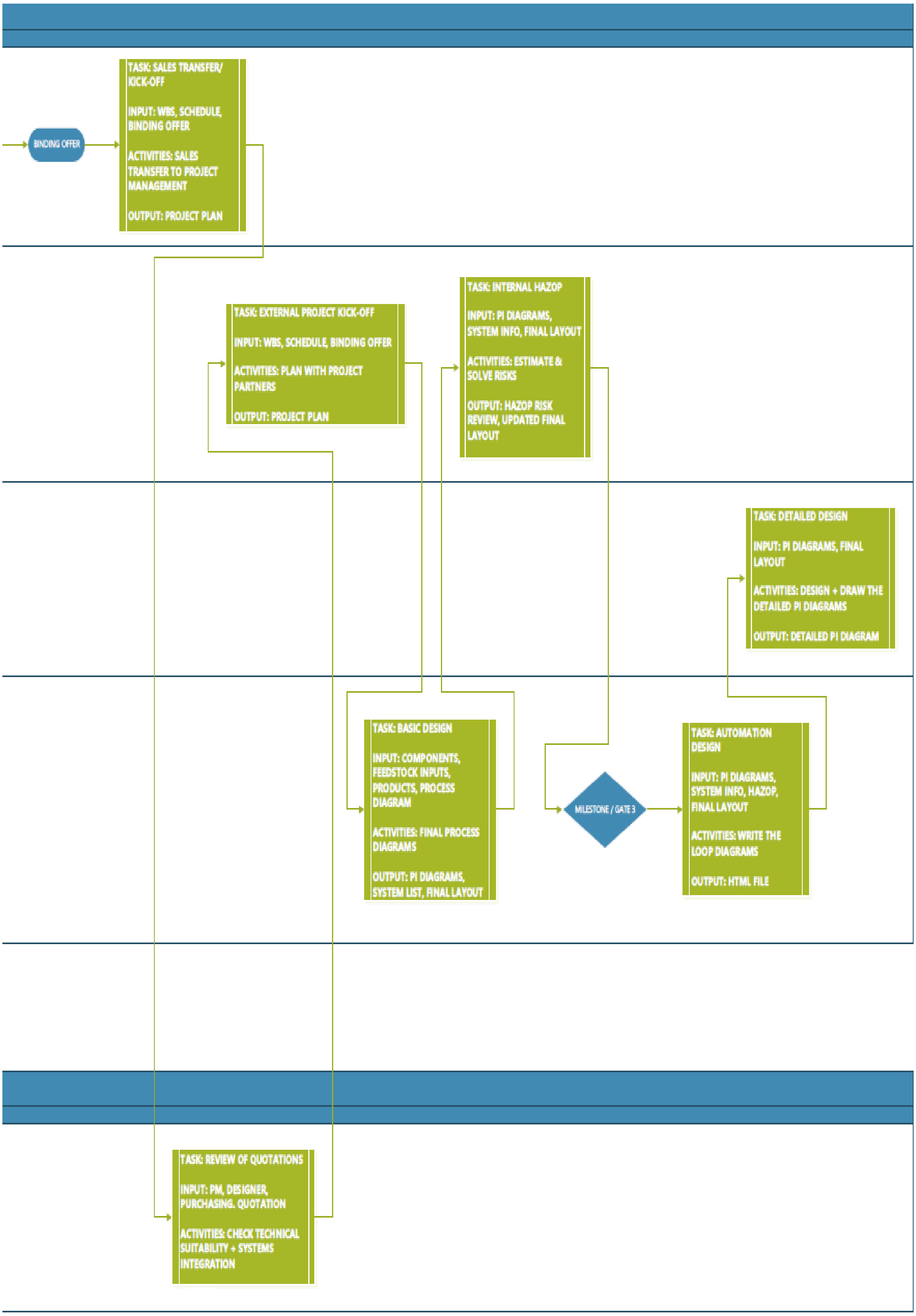
OUTPUT: LAYOUT DESIGN PDF, LAYOUT SIZE REQUIREMENT
TASK: CONCEPTUAL DESIGN

INPUT: CUSTOMER NEEDS, COMPONENT LIST

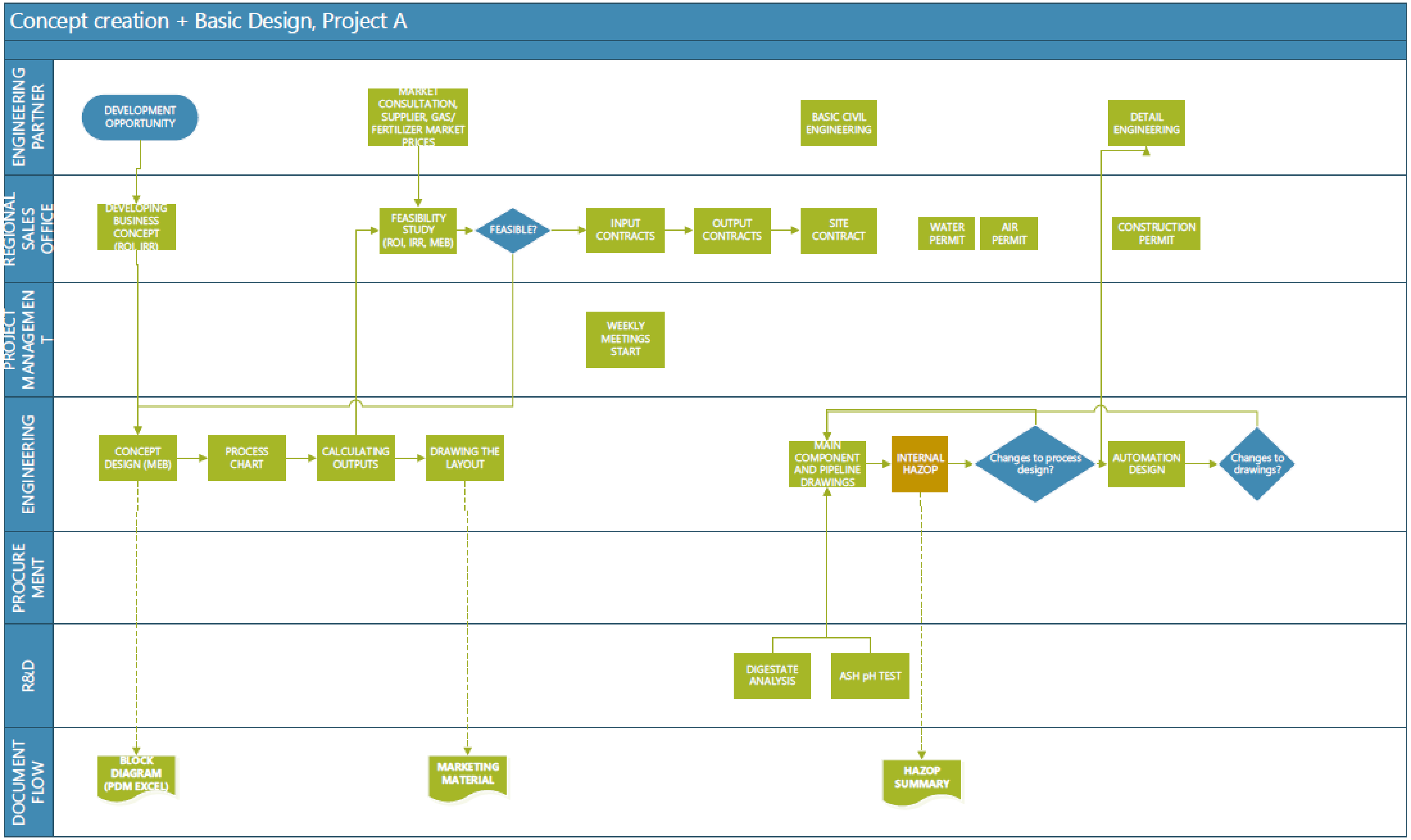
ACTIVITIES: DESIGN THE CONCEPT

OUTPUT: PROCESS DIAGRAM

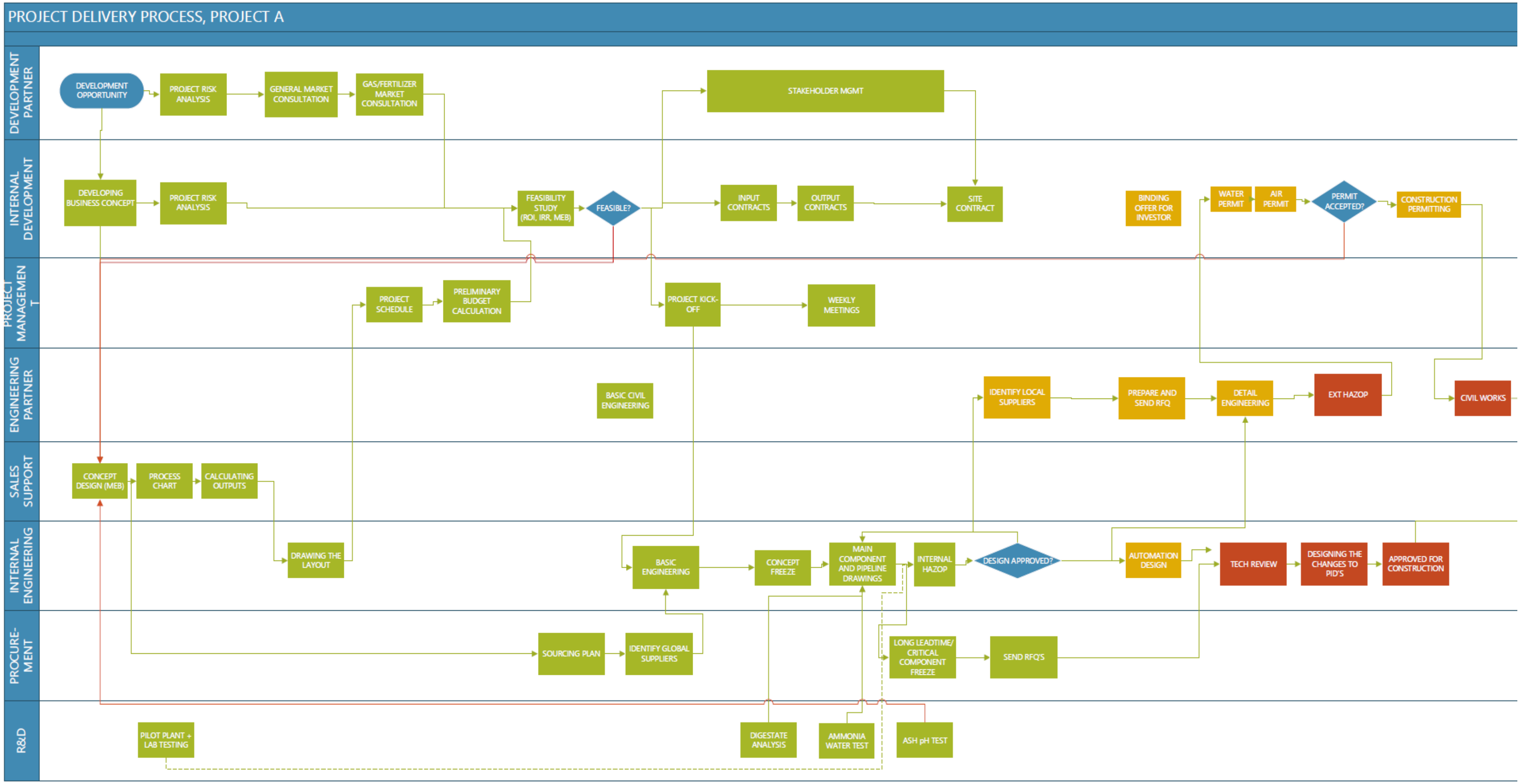

INTERNAL DEVELOPMENT/ SALES
BUDGETARY OFFER
TASK: NEGOTIATIONS/ PERMITTING/PROJECT PARTNERS
INPUT: BUDGETARY OFFER, GANTT
ACTIVITIES: CHOOSE PROJECT PARTNERS, FINALIZE PERMITS
OUTPUT: PERMITS, PROJECT PARTNER CONTRACTS
TASK: PRICE AND LOCALIZE OFFER FOR CUSTOMER
INPUT: PROJECT COSTS, BUSINESS MODEL
ACTIVITIES: FINALIZE THE BINDING OFFER
OUTPUT: BINDING OFFER
BINDING OFFER
PROJECT MANAGEMENT
TASK: ENGINEERING REVIEW
INPUT: PROCESS DIAGRAM, CONCEPT DESIGN,
ACTIVITIES: DO THE WORK-BREAKDOWN STRUCTURE
OUTPUT: WBS, SPECIFICATIONS
TASK: BINDING OFFER COST & RISK REVIEW
INPUT: PMO PEOPLE, CONCEPTUAL DESIGN, QUOTATIONS
ACTIVITIES: ANALYZE RISKS, CALCULATE COSTS
OUTPUT: COST ESTIMATION, RISK ESTIMATIONS
ENGINEERING PARTNER
INTERNAL ENGINEERING
PROCUREMENT
TASK: EXPENSIVE, LONG LEAD TIME BINDING OFFERS
INPUT: WBS
ACTIVITIES: CALCULATE COSTS AND LEAD TIMES
OUTPUT: COSTS, LEAD TIMES


BINDING OFFER
TASK: SALES TRANSFER/ KICK-OFF
INPUT: WBS, SCHEDULE, BINDING OFFER
ACTIVITIES: SALES TRANSFER TO PROJECT MANAGEMENT
OUTPUT: PROJECT PLAN
TASK: EXTERNAL PROJECT KICK-OFF
INPUT: WBS, SCHEDULE, BINDING OFFER
ACTIVITIES: PLAN WITH PROJECT PARTNERS
OUTPUT: PROJECT PLAN
TASK: INTERNAL HAZOP
INPUT: PI DIAGRAMS, SYSTEM INFO, FINAL LAYOUT
ACTIVITIES: ESTIMATE & SOLVE RISKS
OUTPUT: HAZOP RISK REVIEW, UPDATED FINAL LAYOUT
TASK: DETAILED DESIGN
INPUT: PI DIAGRAMS, FINAL LAYOUT
ACTIVITIES: DESIGN + DRAW THE DETAILED PI DIAGRAMS
OUTPUT: DETAILED PI DIAGRAM
TASK: BASIC DESIGN
INPUT: COMPONENTS, FEEDSTOCK INPUTS, PRODUCTS, PROCESS DIAGRAM
ACTIVITIES: FINAL PROCESS DIAGRAMS
OUTPUT: PI DIAGRAMS, SYSTEM LIST, FINAL LAYOUT
MILESTONE / GATE 3
TASK: AUTOMATION DESIGN
INPUT: PI DIAGRAMS, SYSTEM INFO, HAZOP, FINAL LAYOUT
ACTIVITIES: WRITE THE LOOP DIAGRAMS
OUTPUT: HTML FILE
TASK: REVIEW OF QUOTATIONS
INPUT: PM, DESIGNER, PURCHASING. QUOTATION
ACTIVITIES: CHECK TECHNICAL SUITABILITY + SYSTEMS INTEGRATION

APPENDIX E: PROCESS MODEL, PROJECT A, FIRST VERSION



APPENDIX F: PROCESS MODEL, PROJECT A, FINAL VERSION



APPENDIX G: PROCESS MODEL, PROJECT B